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REPOWER – KOSOVO

METHODS FOR CROSS-BORDER EXCHANGE OF POWER SYSTEM RESERVES BETWEEN KOSOVO AND ALBANIA

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REPOWER-KOSOVO

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1. BACKGROUND

The development of an electricity market and power exchange serving both Kosovo and Albania started with ambitious plans to consider a fully integrated market as envisaged in a **Memorandum of Understanding** signed by both Governments in March 2014 to consider "*the establishment of a common Kosovo-Albania electricity market, as a single trading zone, taking into account the technical abilities and the mutual economic gain of Albania and Kosovo.*" Progress on this continued in establishment of a Joint Steering Committee and Working Groups in March 2015. On a separate task, in the summer of 2015, Albania determined that it needed to revamp its market model more quickly (officially approved in July 2016) and to establish the first step in the market integration, which was a day-ahead market, designated the Albanian Power Exchange (APEX). At the beginning of March 2016, the two Governments signed a **Memorandum of Collaboration** following a joined cabinet meeting of the two Governments and, at the end of March 2016, the Governments of Kosovo and Albania signed a **Joint Statement** confirming their earlier common market ambitions but confirming phased approach. APEX can be considered to form the first phase of this. In May 2016, the TSOs **(KOSTT and OST) signed an agreement** for KOSTT to "*join the initiatives of OST for establishment of APEX in form of a shareholder*". These drivers emphasize a continuing coordination between Kosovan and Albanian institutions in the common electricity market development.

All these activities are linked to electricity market integration. Electricity market integration would certainly intensify cross-border power exchanges. However, in addition to electricity market integration it is of utmost importance to constantly keep safe and stabile power system operation. One possibility to keep system operation safe and stabile along with cost reduction is to share power system reserve capacity as it is the case in lot of European countries and is proposed in new European network codes and guidelines. Accordingly, Joint Working Group meeting was held on November 17, 2017 in Tirana where the detailed list of future activities was agreed in the form of Joint Action Plan. One of the Joint Working Group meeting conclusions was to conduct this study on optimal method for reserving cross-border transmission capacity[1] in order to exchange/share power system reserves between two countries. This study was assigned to REPOWER Kosovo project in September 2018. It is supposed to give the whole picture on cross-border reserve dimensioning, sharing and exchange between Kosovo and Albania. Chapter 2 of this study gives overview of European legal framework for power system reserves and cross-border reserve sharing/exchange. Chapter 3 comments European countries' practical experience, while in Chapter 4 regional specifics and Albanian and Kosovo current practices are given. In Chapter 5 scope of foreseen needs and potential services to be shared between Kosovo and Albania are described. Chapter 6 gives proposal for legal framework update needed to implement given proposals. In Chapter 7 all conclusions are recapped. Input data were collected from the ENTSO-e, KOSTT and OST and completed in early January 2019. Draft study was issued in February 2019.

[1] If there is single market with one price no NTC should exists between Kosovo and Albania. The other option is one trading zone with two bidding zones. In this case there is NTC in between two systems. Finally, it is agreed to have two bidding zones.

1.1. Terms of reference

The following table shows the basic definitions of balancing services used in the ENTSO-e. Definitions arose from newly adopted System Operation Guideline [2]. Sufficient amount of power reserves should be procured by Transmission System Operators (TSO) in order to keep frequency in predefined ranges in interconnected operation.

Table 1. Definition of balancing services

Balancing service	Previous name in ENTSO-E CE (UCTE OH)	Activation method	Time domain of response
Frequency Containment Reserve **(FCR)**	**Primary** control reserve	Automatic	Up to 30 seconds
Automatic Frequency Restoration Reserve **(aFRR)**	**Secondary** control reserve	Automatic	Up to 15 minutes
Manual Frequency Restoration Reserve **(mFRR)**	Directly activated **tertiary** control reserve (**Fast**)	Manual	Up to 15 minutes
Replacement Reserves **(RR)**	Schedule-activated **tertiary** control reserve (**Slow**)	Manual	15 minutes – 1 hour

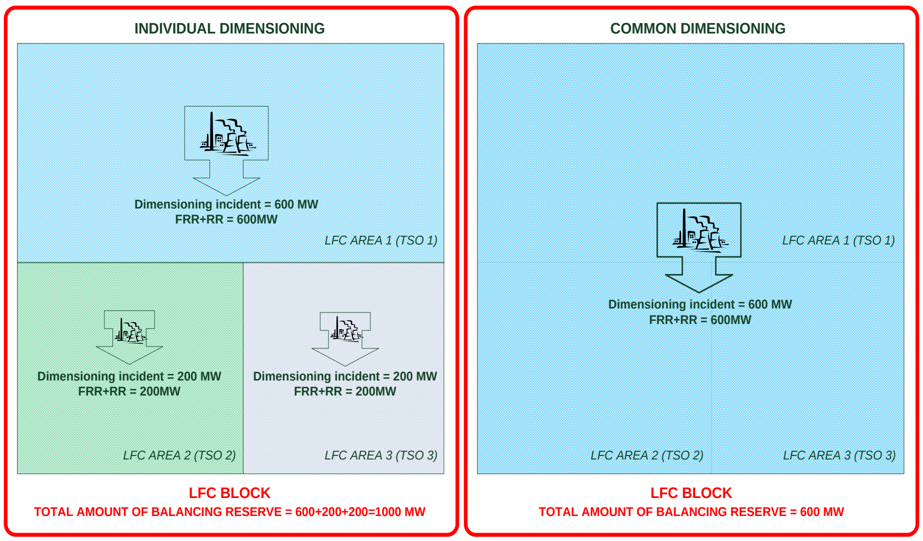
Frequency regulation is common responsibility of all TSO-s within the same synchronous zone. Obligations and roles of all TSOs are defined in the Multilateral Agreement. It is important to note that relevant ENTSO-e group responsible for synchronous area operation assigns FCR obligation to each TSO on yearly basis. There is a project in Central West Europe (CWE) where FCR is procured and shared among TSOs by a common platform. As FCR provisions in South East Europe (SEE) are still obligatory for the producers (FCR is not treated as a market product), there is still no need to share it among the systems. Other balancing services (aFRR, mFRR and RR) can be exchanged/shared among the systems, as shown in the following table [2].

Table 2. Three types of reserve - overview

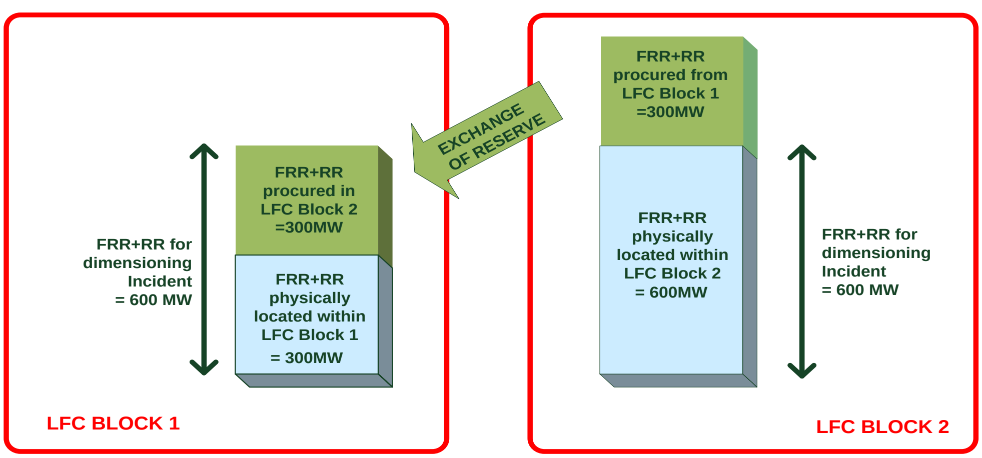
Balancing reserves	Dimensioning	Exchange?	Sharing?
Frequency Containment Reserve (FCR)	**reference incident** in ENTSO-E CE (**3000 MW**, symmetrical), **distributed among TSOs**	**YES** (up to 30% or 100 MW)	**NO**
Frequency Restoration Reserve (aFRR+mFRR)	**jointly with RR**, non-symmetrical. Combination of : • deterministic assessment (**reference incident in LFC Block**) and • probabilistic assessment (99% imbalances for one year)	**YES** (up to 50%)	**YES** (up to 30%)
Replacement Reserves (RR)	**jointly with FRR**	**YES** (up to 50%)	**YES** (up to 30%)

From previous table There are three options how to perform cross border exchange of reserve These options are defined in newly adopted Guideline on Electricity Transmission System Operation (EC 2017/1485) and described in following text:

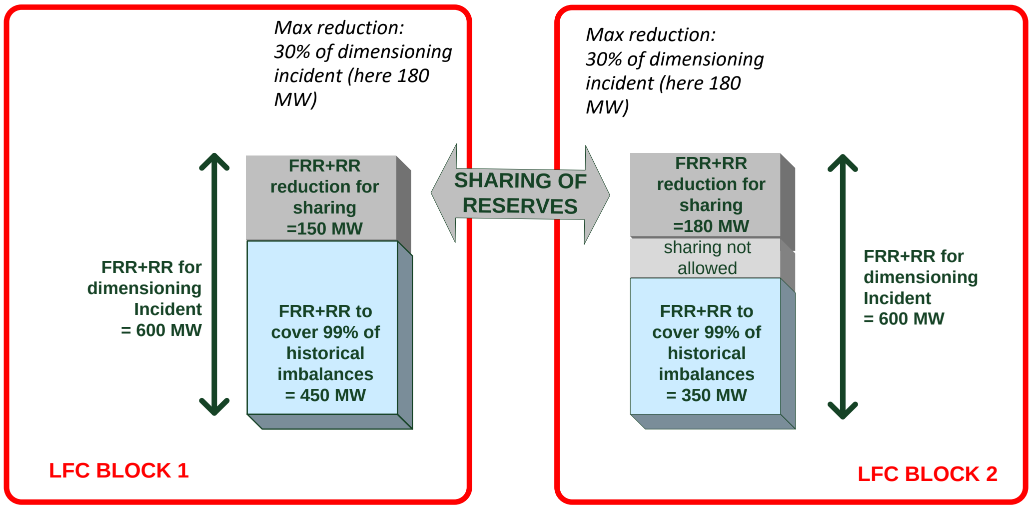
1) **Common dimensioning**: Opportunity for TSOs within common LFC block to decrease the volume of total reserve capacity by introducing common dimensioning incident for the whole LFC block instead of dimensioning based on largest incident in each individual LFC Area. Total reserve capacity for LFC block is distributed among participating TSOs with agreed ratio. This principle is currently applied in Serbia-Montenegro-Macedonia LFC block, as well as in Slovenia – Croatia – Bosnia-Herzegovina LFC block. Graphical illustration is given below [2].



2) **Exchange of reserve**: Opportunity for LFC block to procure part of its reserve (up to 50%) in another LFC block → changing geographical distribution of balancing reserves. Reasons for this kind of reserve exchange can be: Technical – LFC block cannot provide required volume of reserve or Economic – Balancing reserve in another LFC block is more economically efficient. Graphical illustration is given below [2].



3) **Reserve sharing**: Opportunity for LFC blocks to further decrease volume of reserve → common usage of one agreed part of the reserves. Implementation requirements are as follows 1) allowed if: 99% of LFC Block imbalances during one year (probabilistic) is lower than dimensioning incident in MW (deterministic), 2) sharing volume is limited to 30% of the size of dimensioning incident. Graphical illustration is given below [2].



The main task of this study is to explore how to treat cross-border transmission capacity in any of these reserve capacity dimensioning/exchange/sharing principles, taking into account recently adopted legal framework European Commission Guideline on electricity balancing (EU 2017/2195) and Guideline on electricity transmission system operation (EC 2017/1485). Despite the ambition to enlarge the European balancing markets across the borders of the different TSOs' control areas, cross-border balancing markets will work in practice only if there are sufficient physical cross-border transmission capacities available at that point in time when they are actually needed [3]. This is one of the key aspects having to be taken into account in general, regardless which kind of cross-border balancing market concept is finally chosen. The reason is that the different cross-border balancing market services compete with several other cross-border electricity trades in other market segments (e.g. in the hour-ahead and/or day-ahead market).

In theory, the optimal (i.e. welfare-maximizing) allocation of physical cross-border transmission capacity between two market segments (e.g. hour/day-ahead energy market, balancing market) can be explained easily: it is simply the trade-off between the descending marginal value of transmission capacity for cross-border electricity trades in the hour/day-ahead market and the increasing marginal value of transmission capacity for cross-border electricity balancing trades. In practice, however, the welfare-maximizing principle neither can be implemented exactly nor easily. The TSOs rather have to rely on tangible methods to estimate actually available physical cross-border transmission capacity for the balancing market services in case there is no ex-ante reservation for them[2]. In case there are no (or not sufficient) cross-border transmission capacities available at that point in time when they are actually needed, cross-border balancing reserve activation and energy exchange simply has to be denied. In the above-mentioned guideline on

[2] In general, ex-ante reservation of a pre-defined physical cross-border transmission capacity for cross-border balancing energy exchange is possible. However, it is important not to make it interfere into the basic market principles.

electricity balancing published by European Commission it has been proposed that various approaches of treatment of cross-border transmission capacity are used for sharing and exchange of balancing reserves and balancing energy respectively:

1) the TSOs can either use available cross-border transmission capacity after the intraday gate closure or,
2) the capacity can be reserved/procured based on the methodologies described in relevant EC and ENTSO-E documents.

The concept of reserve sharing is based upon the very low probability of the situations in which two TSOs will activate their full amount of FRR+RR at exactly the same time. Reserve sharing brings a strong potential for reducing the amount of balancing reserves through a common use of one agreed part of the reserves within their area. Reserve sharing between Kosovo and Albania would:

1. increase technical possibilities for the provision of reserve capacity
2. increase the competition between service providers
3. decrease the level of total reserve capacity needs (common dimensioning, reserve sharing)
4. decrease overall balancing costs, due to lower reserve capacity and the competition between service providers.

As given in the ToR prepared and adopted by KOSTT and OST, proposed scope of the work in this study is:

1. European legal framework for cross – border exchange/sharing of power system reserve

2. European countries' practical experience and methods used for treatment of the cross-border transmission capacities for cross-border reserve exchange/sharing (existing cooperation, implementation projects, target models)

3. Cross-border transmission capacity assessment

4. Scope of foreseen needs and potential services (products) to be shared between Kosovo and Albania

5. Proposal for eventual legal framework updates to support cross-border exchange of these services between Kosovo and Albania

In addition to the EC Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (especially Articles 38 and 39), this topic is touching whole set of relevant codes and guidelines such as: on Electricity Balancing (GLEB), Capacity Allocation and Congestion Management (CACM), System Operation Guidelines (SOGL), Forward Capacity Allocation (FCA) and Emergency & Restoration Code.

It is also important to note that just recently, the Energy Community Permanent High-Level Group has formally adopted three new pieces of acquis in electricity. In this way Third Energy Package Network Codes and Guidelines will now become part of the Energy Community legal framework. All these Network Codes and Guidelines are developed based on the Third Energy Package aimed at setting common rules on secure system operation, market integration and market functioning. Previously, such rules were drawn up at the national level. However, the implementation of common rules for the whole pan-European energy market became essential for reducing barriers to cross-border trade, increasing the efficiency of system use, promoting network security, and, most importantly, allowing consumers to reap the full benefits of the Third Energy Package.

Deadlines for transposition and implementation of the electricity network codes and guidelines have been set for 12 July 2018, while the deadline for implementation expires three years from there on, mirroring the model applied at the EU level. It is expected that in the near future all Network Codes will be valid in the Energy Community contracting parties, including Kosovo and Albania. It is taken into account in this report.

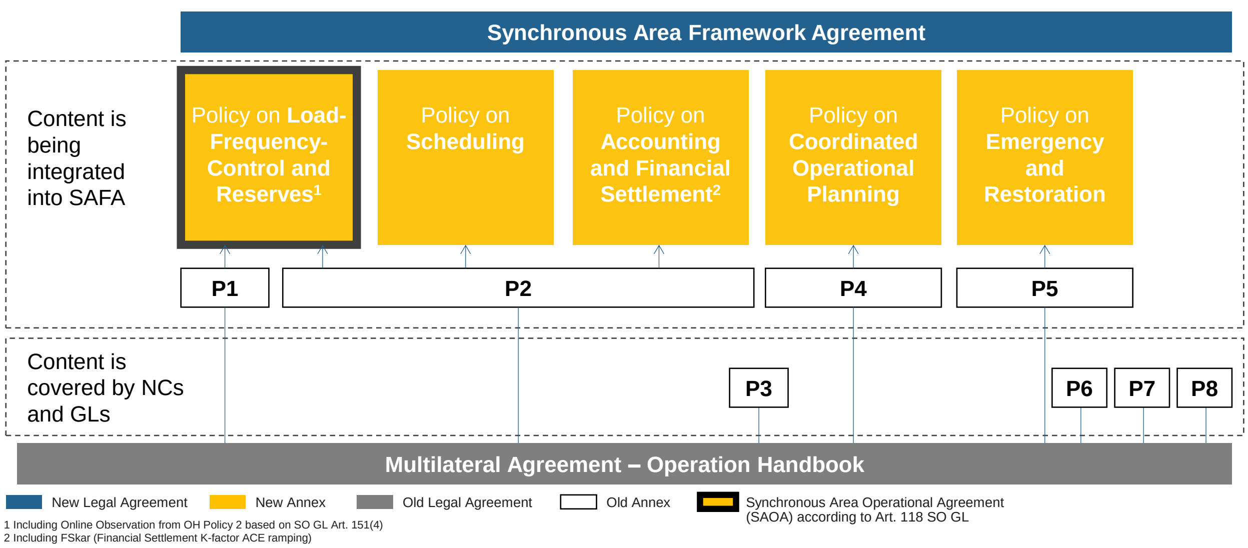
2. EUROPEAN LEGAL FRAMEWORK FOR CROSS – BORDER EXCHANGE/SHARING OF POWER SYSTEM RESERVE

Along with electricity market development in Europe, the TSOs need to implement further steps in operational coordination in overall European electricity system. Multilateral inter-TSO Agreement sets up the framework and design of TSO coordination regarding the essential coordination functions. The framework strikes a balance between national and regional flexibility (to allow for solutions tuned to the needs of this region) and a centralized approach (to ensure cross-regional coordination). Currently, TSOs operation in European interconnected power system is based on this Multilateral Agreement (MLA) signed by 37 European TSOs (KOSTT and OST are not signatories). Technical requirements are defined in Policies [1].

However, along with new regulatory development and above-mentioned Guidelines, new Synchronous Area Framework Agreement (SAFA) is in the preparation phase and it will replace existing MLA. It is expected that new SAFA will be signed in the first half of 2019 and automatically replace existing MLA.

SAFA will form a legal basis and key policies for interconnected operation in the future. Accordingly, network codes and guidelines will give policy instructions and define more details on each specific issue. The following picture shows the relationship between MLA, SAFA, Operational Handbook policies and network codes (NC) and guidelines (GL).

Figure 1 The relationship between MLA, SAFA, Operational Handbook policies, network codes and guidelines (Source: ENTSO-e)



The main difference between existing MLA and new SAFA is that part of previously defined requirements and standards is now written in the Network Codes and Guidelines. In SAFA new Policy of Load-Frequency Control and Performance (LFCR) will consist of three parts:

- Part A (subject to NRA approval)
- Part B (subject to approval by all TSOs bound by System Operation Guidelines (SOGL))
- Part C (agreed among all Regional Group Continental Europe TSOs on voluntary basis)

For example, in the existing Policy 1 LFC block structure is defined in detail, while in upcoming SAFA it is not mentioned at all, since in SOGL it is defined that the relationship between the TSOs inside the LFC control block should be defined in the LFC block agreement.

The development as well as implementation of network codes and guidelines has been identified as a crucial element to spur the ongoing completion of the internal energy market in the EU Third Energy Package. As the Energy Community Contracting parties, Kosovo and Albania are also obliged to transpose and implement EU Third Energy Package.

More specifically, Regulation (EC) 714/2009 sets out the areas in which network codes will be developed and a process for developing them. These codes are a formalized, detailed set of rules pushing for the harmonization of former more nationally oriented electricity markets and regulations. In 2017, after a 4-year lasting co-creating process of ENTSO-E, ACER, the EC and many involved stakeholders from across the electricity sector, the network codes have been developed. After the development of a network code, the implementation phase can start. Very systematic and clear overview of the European legal framework relevant for network operation is given in [6] and will be shortly recapped here as follows.

Eight network codes and guidelines came out of the co-creating process and entered into force. Two are validated by the EU Member States but awaiting validation by European Parliament and Council before being published in the Official Journal of the European Union as commission regulation. Twenty days after publication, the Commission regulation enters into force. Those eight regulations can be subdivided into three groups:

The market codes:

1. The capacity allocation and congestion management guideline (CACM) - published on 25 July 2015
2. The forward capacity allocation guidelines (FCA) – published on 27 September 2016
3. The electricity balancing guideline (GLEB) – published on 23 November 2017

The connection codes:

4. The network code on requirements for grid connection of generators (RfG NC) – published on 14 April 2016
5. The demand connection network code (DCC) – published on 18 August 2016
6. The requirements for grid connection of high voltage direct current systems and direct current - connected power park modules network code (HVDC NC) – published on 8 September 2016

The operation codes:

7. The electricity transmission system operation guideline (SOGL) - published on 25 August 2017
8. The electricity emergency and restoration network code (ER) - published on 24 November 2017

Eight regulations in which common rules for the electricity system and market are described, often referred to as "The network codes", are actually not all network codes by definition. As can be seen from the list above, four out of eight are guidelines (CACM, FCA, GLEB and SO), while the other four are network codes (ER, RfG NC, DCC and HVDC NC). All documents were initially planned to be network codes, and some became guidelines in the development process. It can be argued that a network code is more detailed, while guidelines shift more tasks to the implementation phase. Similarities and differences between network codes and guidelines are listed as follows:

Similarities between guidelines and codes:

- The same value (both are commission regulation and legally binding)
- Both are directly applicable
- The same adoption procedure (Comitology procedure)

Differences between guidelines and codes:

- Legal basis in the electricity regulation
- Development process
- Topics
- Work to be done in the implementation phase

Based on Third EU energy legislation package several network codes and guidelines are more relevant for cross-border reserve sharing, such as:

1. **Guideline on Electricity Transmission System Operation (SOGL)** defines LFC block structure and organization as well as target parameters for frequency and LFC block operation. The most important fact is that dimensioning of reserve should be done on a level of the LFC block

2. **Guideline on Electricity Balancing (GLEB)** which defines terms and conditions for use of reserves and a basis for cross-border implementation projects

3. **Guideline on capacity calculation and congestion management (CACM) and Guideline on Forward capacity allocation (FCA)** which define use of cross border capacities.

The details of each of these guidelines are given in the following subchapters. It is important to keep in mind that all these codes and guidelines are having specific roles in complete, comprehensive regulatory framework. Therefore, these guidelines should not be taken separately, but as a part of a full picture of electricity market and system operation in Europe.

2.1. Guideline on Electricity Balancing (GLEB)

Guideline on Electricity Balancing (GLEB) is fully named as *Commission regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing*. This Regulation lays down a detailed guideline on electricity balancing including the establishment of common principles for the procurement and the settlement of frequency containment reserves, frequency restoration reserves and replacement reserves and a common methodology for the activation of frequency restoration reserves and replacement reserves**. Imbalance netting and the exchange of balancing energy, as well as reserve capacity exchange and reserve capacity sharing are outlined in the GLEB as important to lower overall balancing procurement costs.** The details are given below [3, 6].

This Regulation aims, among other at:

b) fostering effective competition, non-discrimination and transparency in balancing markets;

d) enhancing efficiency of balancing as well as efficiency of European and national balancing markets;

f) integrating balancing markets and promoting the possibilities for exchanges of balancing services while contributing to operational security;

h) contributing to the efficient long-term operation and development of the electricity transmission system and electricity sector in the EU while facilitating the efficient and consistent functioning of day-ahead, intraday and balancing markets;

j) ensuring that the procurement of balancing services is fair, objective, transparent and market-based, avoids undue barriers to entry for new entrants, fosters the liquidity of balancing markets while preventing undue distortions within the internal market in electricity;

l) facilitating the participation of demand response including aggregation facilities and energy storage while ensuring they compete with other balancing services at a level playing field and, where necessary, act independently when serving a single demand facility;

n) facilitating the participation of renewable energy sources and support the achievement of the EU target for the penetration of renewable generation.

As previously noted, imbalance netting and the exchange of balancing energy, as well as the exchange of reserve capacity and reserve sharing are outlined in the GLEB as important to lower overall balancing procurement costs. Before we go into reserve capacity sharing details it is important to keep in mind that priority was given to imbalance netting as defined in Article 3 (128) of the SOGL as "*a process agreed between TSOs that allows avoiding the simultaneous activation of FRR in opposite directions, taking into account the respective FRCEs as well as the activated FRR and by correcting the input of the involved FRPs accordingly*." For example, if two neighboring LFC Areas have at a point in time an opposite system imbalance, the TSOs

GLEB outlines that a pan-European Platform for imbalance netting shall be developed.

can agree to exchange the imbalance, and as such, the activation of counteracting balancing energy (FRR in this case) in both LFC Areas can be avoided. This process leads to an overall reduction in the total volume of activated balancing energy and thus a cost reduction. ACER/CEER (2016) report that imbalance netting continued to be the most successfully applied tool to exchange balancing services in 2015, e.g. in the Netherlands imbalance netting avoided almost 50 % of the balancing needs for that year.

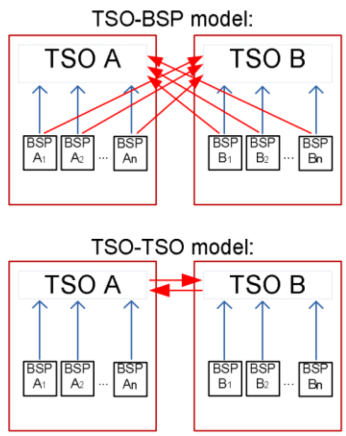
It is further stated that: "*by one year after the approval of the proposal for the implementation framework for a European platform for the imbalance netting process, all TSOs performing the automatic frequency restoration process pursuant to Part IV of Commission Regulation (EU) 2017/000 [SO] shall implement and make operational the European platform for the imbalance netting process. They shall use the European platform to perform the imbalance netting process, at least for the Continental Europe synchronous area*." The International Grid Control Cooperation (IGCC) is the implementation project chosen by ENTSO-E in February 2016 to become the future European Platform for the imbalance netting process. As the latest developments, Croatian and Slovenian TSO-s joined IGCC in February 2019.

A second way to lower overall balancing cost is by the exchange of balancing energy over scheduling areas. The exchange of balancing energy is defined in Article 2(24)) of the GLEB as "*the activation of balancing energy bids for the delivery of balancing energy to a TSO in a different scheduling area than the one in which the activated balancing service provider is connected*".

In general, two models are possible when exchanging balancing energy: TSO-TSO or the TSO-BSP model. In the TSO-TSO model, the balancing service provider provides balancing services to the TSO it is connected with, which then provides these balancing services to the TSO requesting the balancing energy. In the TSO-BSP model, the BSP provides balancing services directly to the contracting TSO, which then provides these balancing services to the requesting TSO. The contracting TSO is defined as "*the TSO that has contractual arrangements for balancing services with a BSP in another scheduling area*" (GLEB, Art. 2(44)).

GLEB it is clearly stated that a pan-European platform for RR, mFRR and aFRR needs to be developed which shall apply a multilateral TSO-TSO model with common merit order lists to exchange all balancing energy bids from all standard products. In other words, TSO-TSO model with common merit order list is the rule, while TSO-BSP model can be used only as a transitional solution.

Figure 2 Balancing (energy, not capacity) mechanism models[3]



The GLEB makes it clear that the TSO-TSO model should be preferred. Exemptions from the TSO-TSO model are possible. Namely, two or more TSOs may at their initiative or at the request of their relevant regulatory authorities develop a proposal for the temporary application of the TSO-BSP model (GLEB, Art.35 (1)). Also, current practices in the form of a TSO-BSP model are allowed in cases where the connecting TSO has not implemented a certain product process, for instance, the Reserve Replacement Process, to allow cross-border exchange of this product (GLEB Art.35 (6)). The TSO-TSO model with common merit order list can lead to savings in the procurement of balancing energy as resources can be more efficiently allocated.

In order to conduct imbalance netting or the exchange of balancing energy, available transmission capacity (ATC) between scheduling areas or LFC Areas is a prerequisite. An exemption to this statement holds for the exchange and operation of FCR (GLEB, Art. 38(4)).

In other words, TSOs are not allowed to increase TRM for exchanging/sharing of balancing capacity for FRR or RR, while FCR can be exchanged using TRM, calculated as described by CACM, Art. 22.

Related to this fact, in GLEB Art. 36(1) it is demanded that all TSOs shall use the available cross-border capacity[4] after the cross-border intraday gate closure for the exchange of balancing energy or for operating the imbalance netting process. Concretely, two situations can exist, assuming there is spare capacity in both directions between two LFC Areas:

1. The imbalances in both areas are opposite:

[3] Illustration: SEE regional electricity balancing study, Energy Community, EKC, 2014

[4] It is also referred as "cross-zonal capacity"

First, imbalance netting will take place. Then, if the imbalance in one of the areas persists and the transmission line is not congested, the exchange of balancing energy can take place.

2. The imbalances in both areas are in the same direction:

No imbalance netting will take place. The exchange of balancing energy can take place.

A methodology per capacity calculation region will be developed to calculate the available cross-zonal capacity within the balancing time frame (GLEB, Art 37(3)). Cross-zonal transmission capacity can be reserved for the exchange of balancing (reserve) capacity or through the sharing of reserves. And thus, indirectly also for balancing energy exchange.

Cross-zonal transmission capacity can be reserved for the reserve capacity exchange or reserve capacity sharing.

The exchange of balancing (reserve) capacity is defined in GLEB Art. 2(25) as „*the provision of balancing capacity to a TSO in a different scheduling area than the one in which the procured BSP is connected*."

2.2. Guideline on Electricity Transmission System Operation (SOGL)

Guideline on Electricity Transmission System Operation (SOGL) is fully named as *Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation*. For the purpose of safeguarding operational security, frequency quality and the efficient use of the interconnected system and resources, this Regulation lays down detailed guidelines on:

a) requirements and principles concerning operational security
b) rules and responsibilities for the coordination and data exchange between TSOs, between TSOs and DSOs, and between TSOs or DSOs and significant grid users, in operational planning and in close to real-time operation
c) rules for training and certification of system operator employees
d) requirements on outage coordination
e) requirements for scheduling between the TSOs' control areas and
f) rules aiming at the establishment of a framework for load-frequency control and reserves.

From the reserve capacity exchange and sharing aspects it is important to note that among other SOGL sets the limitations for FRR exchange as follows:

***Limits for the exchange of FRR** are defined as follows:*

- The TSOs of a LFC block shall ensure that at least 50 % of their total combined reserve capacity on FRR resulting from the FRR dimensioning rules in Article 157(1) and before any reduction due to the sharing of FRR in accordance with Article 157(2) remains located within their LFC block

- The TSOs of the LFC areas constituting a LFC block shall have the right, if needed, to specify internal limits, for the exchange of FRR between the LFC areas of the LFC block in the LFC block operational agreement to:

- *avoid internal congestions due to the activation of the reserve capacity on FRR subject to the exchange of FRR*
- *ensure an even distribution of FRR throughout the synchronous area and LFC blocks in case of network splitting*
- *avoid that the stability of the FRP or the operational security is affected.*

The same principle is valid for RR exchange limits:

***Limits for the exchange of RR** are defined as follows:*

- The TSOs of the LFC areas constituting a LFC block shall ensure that at least 50 % of their total combined reserve capacity on RR resulting from the RR dimensioning rules according to Article 160(3) and before any reduction of reserve capacity on RR as a result of the sharing of RR according to Article 160(4) and Article 160(5) remains located within their LFC block

- The TSOs of the LFC areas constituting a LFC block shall have the right, if required, to define internal limits for the exchange of RR between LFC areas of the LFC block in the LFC block operational agreement as to:

- *avoid internal congestions due to the activation of reserve capacity on RR subject to the exchange of RR*
- *ensure an even distribution of RR throughout the synchronous area in case of network splitting*
- *avoid that the stability of the RRP or the operational security is affected.*

SOGL also defines imbalance netting process, as well as cross-border FRR and RR activation, cross—border control processes and TSO notification needed. The details are given as follows.

Imbalance netting process

The control target of the imbalance netting process aims at reducing the amount of simultaneous counteracting FRR activations of the different participating LFC areas by imbalance netting power interchange. Each TSO has the right to implement the imbalance netting process for the LFC areas in the same LFC block, between different LFC blocks or between different synchronous areas, by concluding an imbalance netting agreement. TSOs implement the imbalance netting process in a way which does not affect:

- the stability of the frequency containment process of the synchronous area or synchronous areas involved in the imbalance netting process;
- the stability of the frequency restoration process and the reserve replacement process of each LFC area operated by participating or affected TSOs; and
- operational security.

Imbalance netting power interchange between LFC areas of a synchronous area should be implemented in at least one of the following ways:

- by defining an active power flow over a virtual tie-line which shall be part of the frequency restoration control error (FRCE) calculation;
- by adjusting the active power flows over HVDC interconnectors.

It should be implemented in a way which does not exceed the actual amount of FRR activation necessary to regulate the FRCE of that LFC area to zero without imbalance netting power interchange. All TSOs participating in the same imbalance netting process ensure that the sum of all imbalance netting power interchanges is equal to zero. Moreover, the imbalance netting process includes a fallback mechanism which shall ensure that the imbalance netting power interchange of each LFC area is zero or limited to a value for which operational security can be guaranteed.

Where a LFC block consists of more than one LFC area and the reserve capacity on FRR as well as the reserve capacity on RR is calculated based on the LFC block imbalances, all TSOs of the same LFC block shall implement an imbalance netting process and interchange the maximum amount of imbalance netting power with other LFC areas of the same LFC block.

All TSOs of the ENTSO-e declared International Grid Control Cooperation (IGCC) project as referent project for the implementation of the imbalance netting (see Chapter 3). Therefore, there is a possibility to establish an imbalance netting process with Kosovo and Albania as well.

Beside the implementation of IGCC, all TSOs of the LFC blocks involved need to comply with FRCE target parameters and FRR dimensioning rules, as well as the obligations and responsibility structure, regardless of imbalance netting power interchange.

Cross-border FRR and RR activation process

> *Each TSO has the right to implement the cross-border FRR and/or RR activation process for LFC areas within the same LFC block, between different LFC blocks or between different synchronous areas by concluding a cross-border FRR and/or RR activation agreement.*

TSOs can implement the frequency restoration power interchange between LFC areas of the same synchronous area through one of the following actions:

- defining an active power flow over a virtual tie-line which shall be part of the FRCE calculation where FRR activation is automated;
- adjusting a control program or defining an active power flow over a virtual tie-line between LFC areas where FRR activation is manual; or
- adjusting the active power flows over HVDC interconnectors.

The cross-border FRR and RR activation process need to include a fallback mechanism which shall ensure that the frequency restoration power interchange of each LFC area is zero or limited to a value for which operational security can be guaranteed.

General requirements for cross-border control processes

All TSOs participating in an exchange or sharing of FRR or RR shall implement a cross-border FRR or RR activation process, as appropriate.

All TSOs of a synchronous area need to specify in the synchronous area operational agreement the roles and responsibilities of the TSOs implementing an imbalance netting process[5], a cross-border FRR activation process or a cross-border RR activation process between LFC areas of different LFC blocks or of different synchronous areas. All TSOs participating in the same imbalance netting process, in the same cross-border

[5] Draft agreement is prepared for RG CE

FRR activation process or in the same cross-border RR activation process shall specify in the respective agreements, the roles and responsibilities of all TSOs including:

- the provision of all input data necessary for:
    - the calculation of the power interchange with respect to the operational security limits; and
    - the performance of real-time operational security analysis by participating and affected TSOs;
- the responsibility of calculating the power interchange; and
- the implementation of operational procedures to ensure the operational security.

Also, all TSOs participating in the same imbalance netting process, cross-border FRR activation process or cross-border RR activation process have the right to specify a sequential approach for calculation of the power interchange. The sequential calculation of the power interchange shall allow any group of TSOs operating LFC areas or LFC blocks connected by interconnections to interchange imbalance netting, frequency restoration or reserve replacement power among themselves ahead of an interchange with other TSOs.

TSO notification

TSOs who intend to implement an imbalance netting process, a cross-border FRR activation process, a cross-border RR activation process, an exchange of reserves or a sharing of reserves shall, 3 months before exercising such right, notify all other TSOs of the same synchronous area about:

1) the TSOs involved
2) the expected amount of power interchange due to the imbalance netting process, cross-border FRR activation process or cross-border RR activation process
3) the reserve type and maximum amount of exchange or sharing of reserves; and
4) the timeframe of exchange or sharing of reserves.

Where an imbalance netting process, a cross-border FRR activation process or a cross-border RR activation process is implemented for LFC areas that are not part of the same LFC block, each TSO of the concerned synchronous areas shall have the right to declare itself as an affected TSO to all TSOs of the synchronous area based on an operational security analysis and within 1 month after receipt of the notification. The affected TSO shall have the right to:

- require the provision of real-time values of imbalance netting power interchange, frequency restoration power interchange and control program necessary for real-time operational security analysis; and

- require the implementation of an operational procedure enabling the affected TSO to set limits for the imbalance netting power interchange, frequency restoration power interchange and control program between the respective LFC areas based on operational security analysis in real-time.

2.3. Guideline on capacity calculation and congestion management (CACM)

Guideline on capacity allocation and congestion management (CACM) is fully named as *Commission regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.*

CACM lays down detailed guidelines on cross-zonal capacity allocation and congestion management in the day-ahead and intraday markets, including the requirements for the establishment of common methodologies for determining the volumes of capacity simultaneously available between bidding zones, criteria to assess efficiency and a review process for defining bidding zones. It is applied to all transmission systems and interconnections in the EU except the transmission systems on islands which are not connected with other transmission systems via interconnections.

CACM aims at:

a) promoting effective competition in the generation, trading and supply of electricity;

b) ensuring optimal use of the transmission infrastructure;

c) ensuring operational security;

d) optimizing the calculation and allocation of cross-zonal capacity;

e) ensuring fair and non-discriminatory treatment of TSOs, NEMOs, the Agency (ACER), regulatory authorities and market participants;

f) ensuring and enhancing the transparency and reliability of information;

g) contributing to the efficient long-term operation and development of the electricity transmission system and electricity sector in the EU;

h) respecting the need for a fair and orderly market and fair and orderly price formation;

i) creating a level playing field for NEMOs;

j) providing non-discriminatory access to cross-zonal capacity.

CACM Article 20(4) is explicitly referring to South East Europe:

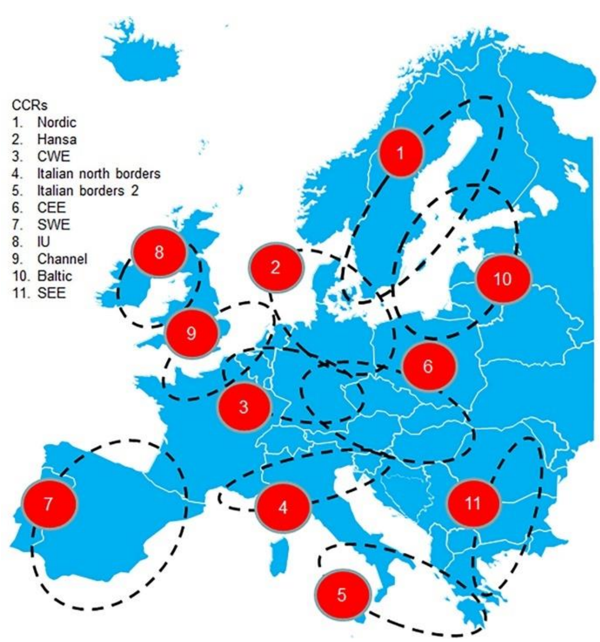
No later than six months after at least all South East Europe Energy Community Contracting Parties participate in the single day-ahead coupling, the TSOs from at least Croatia, Romania, Bulgaria and Greece shall jointly submit a proposal to introduce a common capacity calculation methodology using the flow-based approach for the day-ahead and intraday market time-frame. The proposal shall provide for an implementation date of the common capacity calculation methodology using the flow-based approach of no longer than two years after the participation of all SEE Energy Community Contracting Parties in the single day-ahead coupling. The TSOs from EU Member States which have borders with other regions are encouraged to join the initiatives to implement a common flow-based capacity calculation methodology with these regions.

One of the very important CACM requirements is to establish 'capacity calculation regions' - the geographic areas in which coordinated capacity calculation is applied. Capacity calculation should be done on a regional level based on predefined methodology. Article 20(1) of CACM Regulation stipulates that there must be one common Capacity Calculation Methodology per each CCR.

All TSOs in each capacity calculation region (CCR) shall ensure that cross-zonal capacity is recalculated within the intraday market time-frame based on the latest available information. The frequency of this recalculation shall take into consideration efficiency and operational security. By three months after the entry into force of CACM all TSOs were supposed to jointly develop a common proposal regarding the determination of capacity calculation regions.

By 17 November 2015, as required by CACM, all TSOs submitted CCR proposal to their National Regulatory Authorities with 11 regions, as shown on the following Figure.

Figure 3 Capacity calculation regions initially proposed by the TSOs (source: ENTSO-e)



By letter of 17 May 2016, the Chair of the Energy Regulators' Forum informed ACER of the outcome of all attempts between Regulatory Authorities to reach a unanimous decision on the CCR Proposal, asking ACER to adopt a decision following the failure of Regulatory Authorities to adopt a common decision.

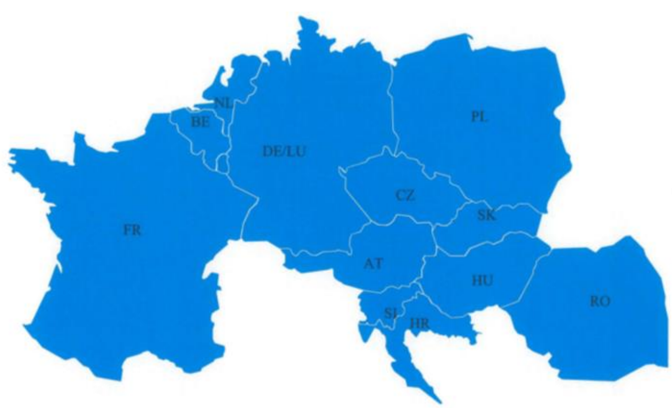
However, on 17 November 2016 ACER published its Decision 06/2016, by which 10 CCRs have been established, instead of earlier 11 CCRs proposed by the TSOs:

1. Capacity Calculation Region 1: 'Nordic',
2. Capacity Calculation Region 2: 'Hansa',
3. Capacity Calculation Region 3: Core (merged 'Central Eastern Europe (CEE)' and 'Central-West Europe (CWE)'),
4. Capacity Calculation Region 4: 'Italy North',
5. Capacity Calculation Region 5: 'Greece-Italy (GRIT)',
6. Capacity Calculation Region 6: 'South-West Europe (SWE)',
7. Capacity Calculation Region 7: 'Ireland and United Kingdom (IU)',
8. Capacity Calculation Region 8: 'Channel',
9. Capacity Calculation Region 9: 'Baltic', and
10. Capacity Calculation Region 10: South-east Europe (SEE).

For the region of South East Europe there are two relevant CCRs: SEE and Core.

Figure 4 Capacity Calculation Region 10: South East Europe (source: ACER)

Figure 5 Capacity Calculation Region 3: Core (source: ACER)



Since it is prepared by the ENTSO-e, Kosovo is not recognized as control area in the CCR. Moreover, Energy Community parties are currently not part of CCRs.

ACER's CCRs include the borders between EU member states. In above mentioned ACER's decision on CCRs, CCR SEE includes bidding zone borders between: GR-BG and BG-RO. In Recital 84 ACER also says: "*Since the CACM Regulation aims at extending market coupling beyond the EU borders (ref to CACM Article 20.4), the Agency stresses the importance to prepare the future extension of CCRs to third countries well in advance. The Agency therefore welcomes that the CCRs Proposal provides for a planning for the future extension of the current CCRs, including to third countries*".

It is important to note that EU TSOs have obligation to implement CACM, while non-EU TSOs have so called "early implementation" obligation. Accordingly, there is an initiative to define the status of the Energy Community Contracting Parties borders (in between the EnC Contracting Parties as well as in between EU member states and EnC Contracting Party). SEE CCR (CCR 10) specifics is that EU TSOs are strongly connected with non-EU TSOs. Proposal of Coordinated Capacity Calculation (CCC) methodology has already been developed by RO-BG-GR TSOs and submitted to their NRAs. Proposed CCC methodology (NTC based) concerns not only EU borders (RO-BG, BG-GR), but also "non-EU" borders (BG-RS, GR-TR, RO-RS, BG-MK …).

Comprising the latest developments, as "early implementation of the codes", in October 2018 informal Shadow CCR has been published. Energy Community is supporting and developing idea on Shadow CCR SEE, with proposed starting date of 01/01/2020.

Figure 6 CCR 10 and WB6 countries (source: SCC, Vienna, 2018)

3. EUROPEAN COUNTRIES' PRACTICAL EXPERIENCE AND METHODS USED FOR TREATMENT OF THE CROSS-BORDER TRANSMISSION CAPACITIES FOR CROSS-BORDER RESERVE EXCHANGE/SHARING (EXISTING COOPERATION, IMPLEMENTATION PROJECTS, TARGET MODELS)

Generally, today's reserve markets in Europe are still uncoordinated [8]. This implies that most of the TSOs do the dimensioning, procurement and activation of reserves for its own control area, without any coordination with neighboring control areas. However, a limited number of examples of cross-border reserve coordination and sharing exist. Especially the cross-border coordination of FCR is already well established, with a coordinated dimensioning and (partially) coordinated procurement of FCR (e.g., the Belgian TSO procures FCR in France, and the procurement of FCR is jointly organized by Germany, Switzerland and the Netherlands). The Nordic countries have had a fully coordinated reserve market since 2002.

One of the reasons that cross-border coordination of FCR is already in place is a large common interest. FCR is dimensioned to maintain the system frequency in the time frame of seconds in case of a worst-case contingency and it is dimensioned on 3000 MW in continental Europe interconnection and distributed among TSOs on a yearly basis. Moreover, a common procurement of FCR results in lower costs for TSOs compared to national procurement, and this is a main driver for FCR cooperation.

Other examples are the imbalance netting between several countries (Belgium, Netherlands, Germany, Denmark, Czech Republic, Switzerland,Austria, etc.) and the reserve sharing of 300 MW mFRR between Belgium (Elia), Netherlands (Tennet NL) and part of Germany (Tennet DE) [8]. There is mFRR capacity common dimensioning exist between Slovenia, Croatia and BiH (SHB LFC block), as well as between Serbia, Montenegro and Macedonia (SMM LFC block).

However, as said before, most of European countries still procure balancing (reserve) capacity and balancing energy separately with a goal to ensure the balancing capacity inside its LFC block. In the past years, with a goal to reduce the costs of procurement of balancing capacity, several projects were launched, especially in SEE region, which could be a good basis for KOSTT-OST cooperation. The following Table shows the details on the European practical experience with reserve sharing and/or common dimensioning.

Table 3. European practical experience with reserve sharing and/or common dimensioning

Cross border balancing projects	Involved	Description
FCR Cooperation	France, Germany, Switzerland, Austria, Netherlands, Belgium, etc.	Common procurement and exchange of FCR
SHB LFC block common dimensioning and exchange of reserves	Slovenia, Croatia, Bosnia & Herzegovina	Common dimensioning and exchange of mFRR (overall saving of cca 40 % of needed individual reserves)
SMM LFC block common dimensioning and exchange of reserves	Serbia, Macedonia, Montenegro	Common MOL for mFRR and RR
SL-IT cross border mFRR	Slovenia, Italy	Exchange of mFRR
Imbalance Netting Process	Austria, Croatia, Slovenia	Real time imbalance netting
aFRR cooperation	Austria, Germany	Platform for common procurement and activation process of aFRR

Clear benefits of this approach are given in the first example listed above. This project for cross-border exchange of FCR capacity started in late 2015 and involved the France, Germany, Austria, The Netherlands and Swiss TSOs. ACER/CEER (2016) reports that the exchange of balancing capacity allowed a reduction of approximately 14% in the overall balancing capacity procurement costs for FCR in 2015 when comparing with 2014 for these four countries recorded [6].

The second example (Slovenia – Croatia – BiH) is also indicative with estimated savings of about 40% in terms of individual mFRR capacity needs.

In the third example (Serbia – Montenegro - Macedonia) total shared RR capacity is reduced for 41.5% compared to individual approach on the level of SMM LFC block. In real terms with reserve sharing 425 MW of generation capacity is released for commercial use in SMM LFC block. Decrease costs for reserve capacity payments are estimated at around 11 mil.€/year for SMM LFC block.

Treatment of cross-border capacity in above mentioned projects is mostly through available cross-border capacities. On the borders, use-it-or-lose-it principle is applied for unused capacity, and unused capacity could be easily used for balancing purposes. There could be an option in reserve sharing contract to use different options such as use of TRM and/or additional capacity assessment strictly before activation, but it should be mutually agreed and, if necessary, approved by respective NRAs.

Fourth example is also very interesting. Slovenian TSO (ELES) is having two sharing agreements as given on the following Figure. The first one is SHB control block contract where common dimensioning process and exchange of reserves are defined. The second one is agreement with Italian TSO TERNA, where TSOs share the reserves. If congestion occurs and there is no cross-border transmission capacity, reserve could easily be shared from other side, because there is always free cross-border capacity in uncongested direction.

Figure 7 TERNA – ELES - SHB reserve sharing contract principles

Moreover, latest developments based on GLEB foresee implementation of four pan-European processes:

1. IGCC (International Grid Control Cooperation)[6], currently in operation, in order to establish a mechanism for imbalance netting
2. PICASSO, in order to establish common MOL and activation optimization function for aFRR
3. MARI, in order to establish common MOL and activation optimization function for mFRR
4. TERRE, in order to establish common MOL and activation optimization function for RR

It is important to note that above mentioned projects do not tackle reserve procurement. They optimize use of contracted reserve on a pan-European level through available cross-border capacities.

It is strongly recommended that KOSTT and OST establish mutual imbalance netting process and/or join IGCC projects. Significant reduction of activated aFRR and ACE values are evident in all TSOs after implementation of the imbalance netting.

Figure 8 IGCC membership status (source: ENTSO-e)

[6] The International Grid Control Cooperation (IGCC) is the implementation project chosen by ENTSO-E in February 2016 to become the future European Platform for the imbalance netting process as defined by GLEB (Art. 22). IGCC was launched in October 2010 as a regional project and has grown to cover 20 countries (23 TSOs) across continental Europe, including all those that need to implement the imbalance netting platform according to the GLEB.

3.1. European practice in reserve capacity usage, procurement, settlement rule and cost recovery scheme

The following 16 figures show European practice with FCR, aFRR, mFRR and RR capacity in four main aspects:

1. using this type of reserve capacity (yes or no),
2. procurement principle (mandatory, market or hybrid),
3. settlement rule (pay as bid, marginal price or regulated price) and
4. cost recovery scheme (grid user (through tariff), balancing responsible party or hybrid).

Data source is ENTSO-e Survey on Ancillary Services Procurement, Balancing Market Design released in May 2018 [12].

These figures are representing only reserve capacity details, while reserve energy specifics (activation rule, product resolution, distance to real time etc.) can be found in [12].

Data for Kosovo, Albania, Montenegro and Bulgaria were not collected and analyzed within this survey. Since KOSTT is still not recognized as full member of the ENTSO-e and LFC area, Kosovo is not graphically represented on the following figures.

3.1.1. Frequency containment reserve (FCR)

Figure 9 Using FCR in Europe

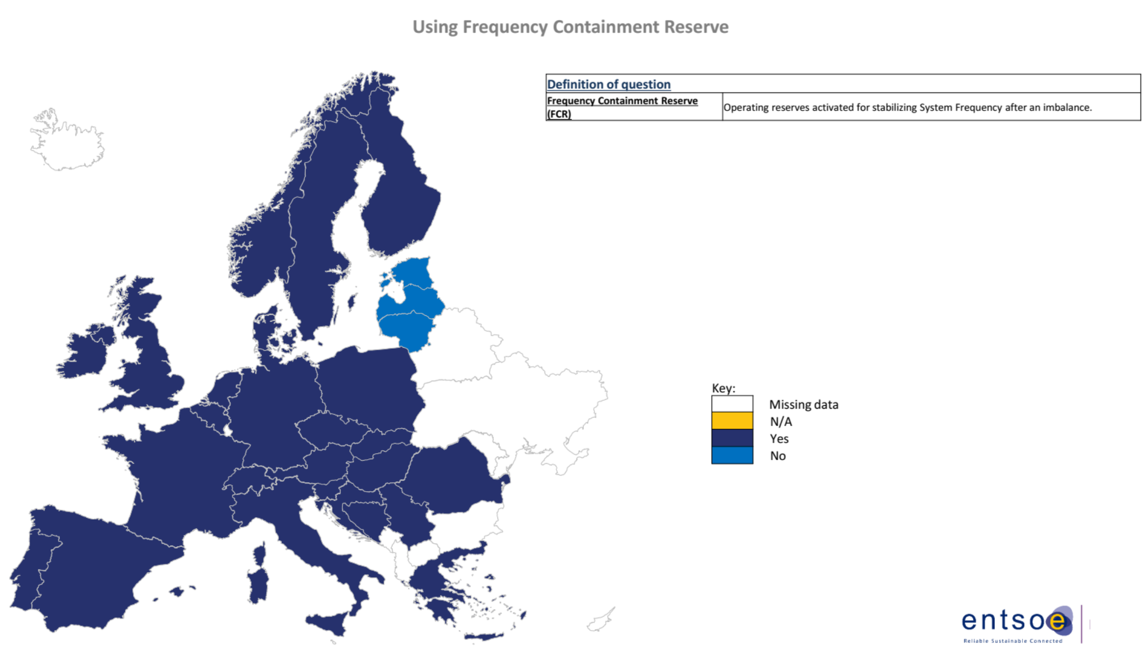


Figure 10 FCR capacity procurement scheme

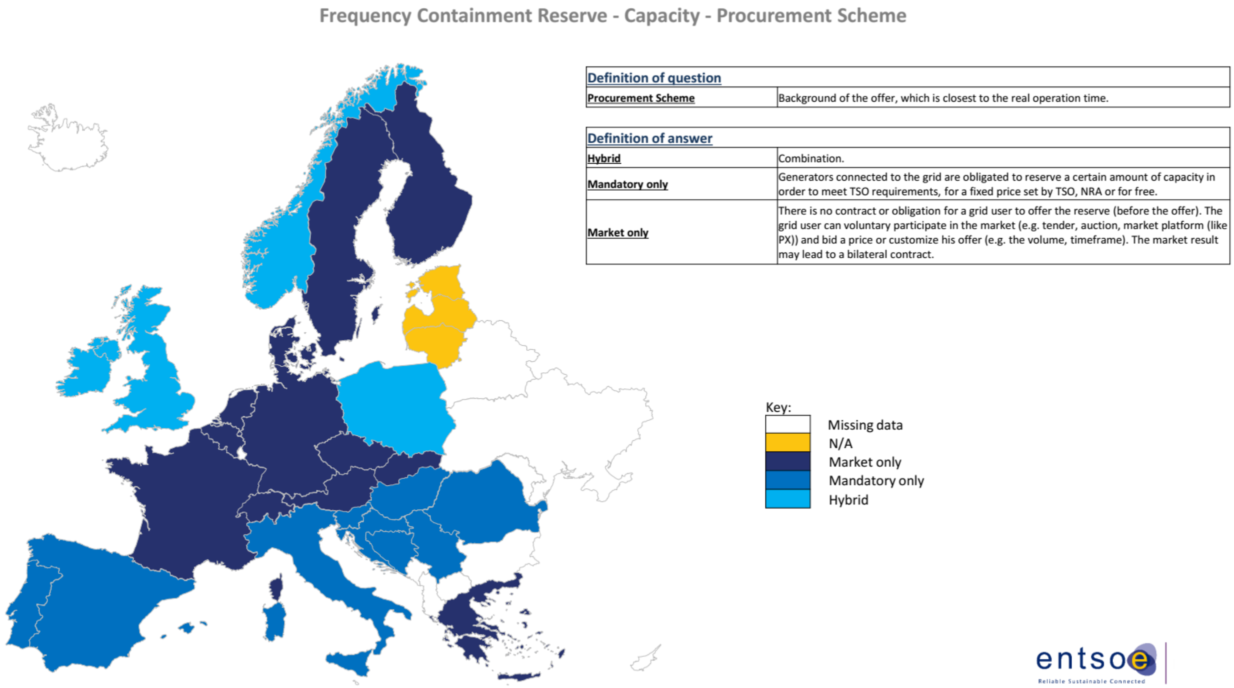


Figure 11 FCR capacity settlement rule

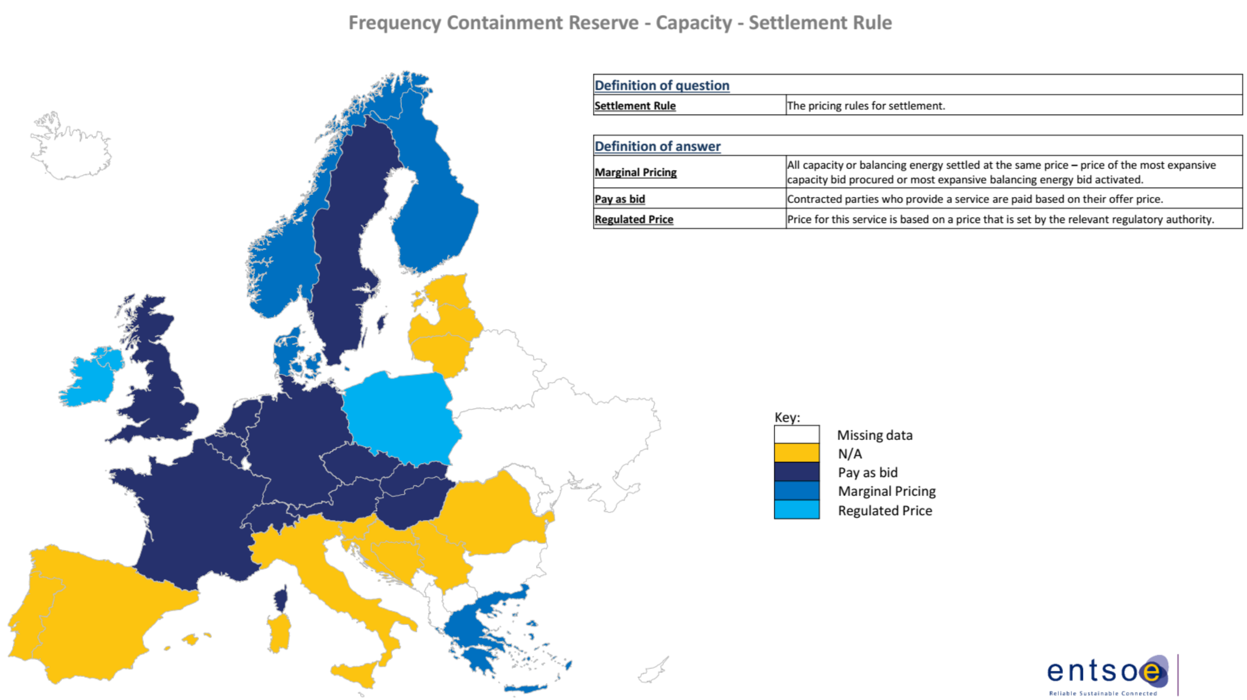
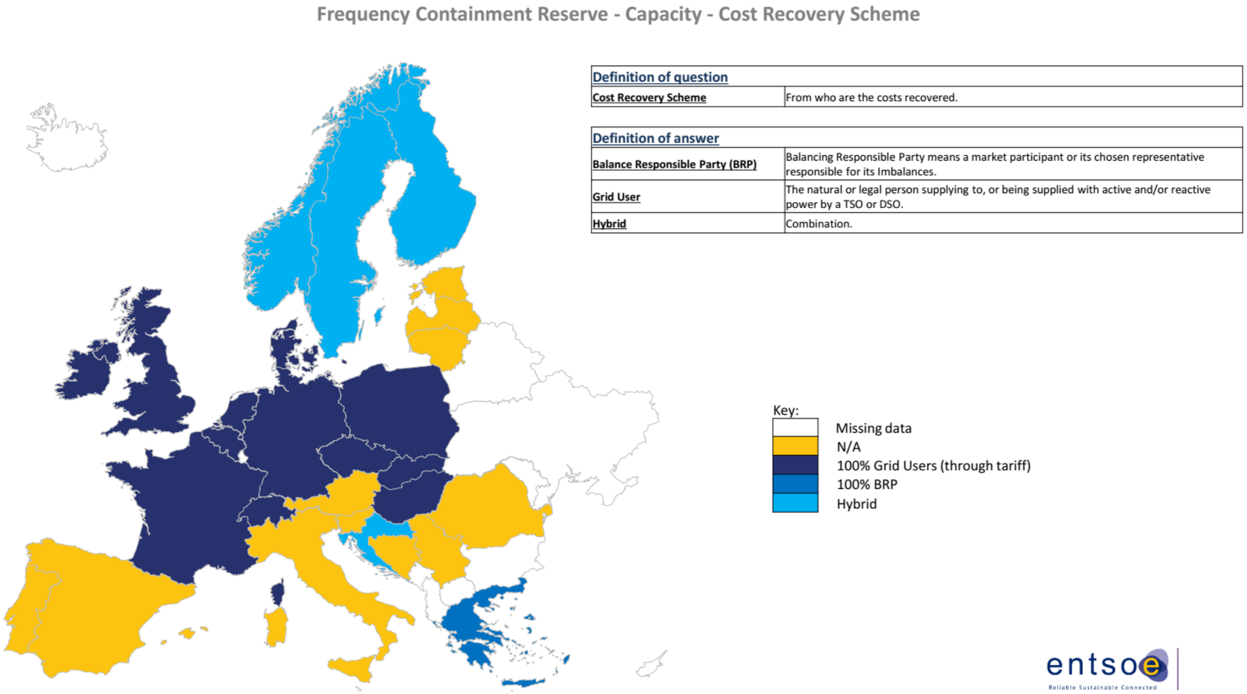


Figure 12 FCR capacity cost recovery scheme



3.1.2. Automatic frequency restoration reserve (aFRR)

Figure 13 Using aFRR in Europe

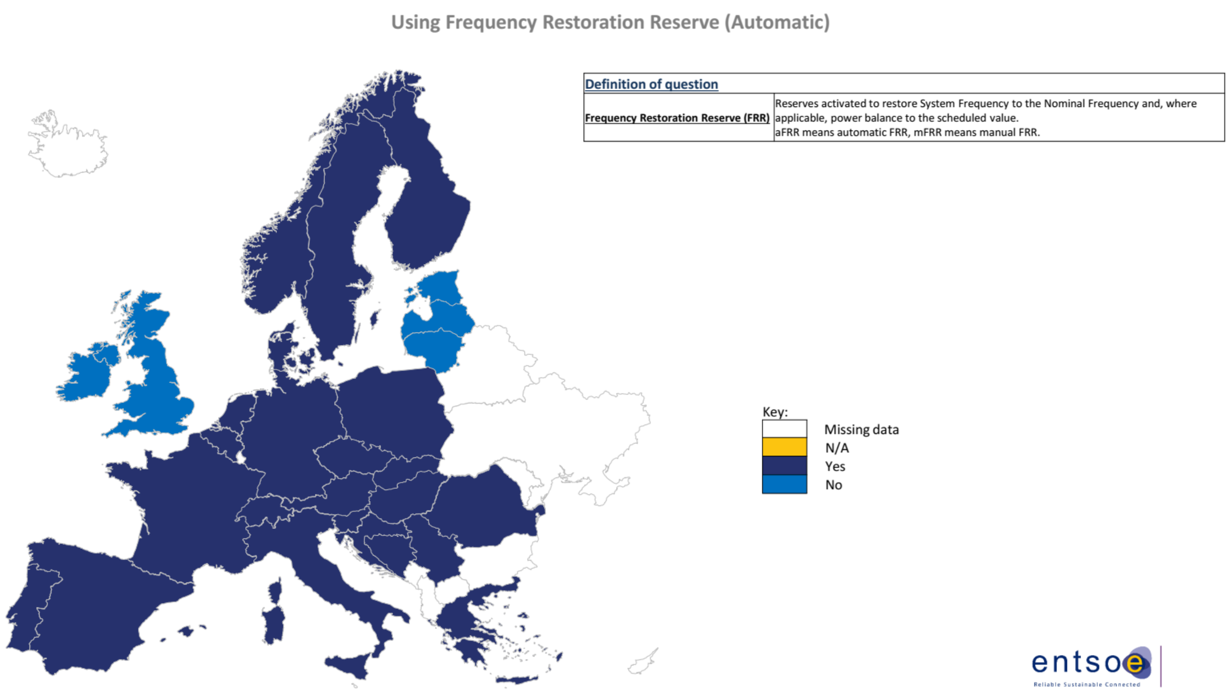


Figure 14 aFRR capacity procurement scheme

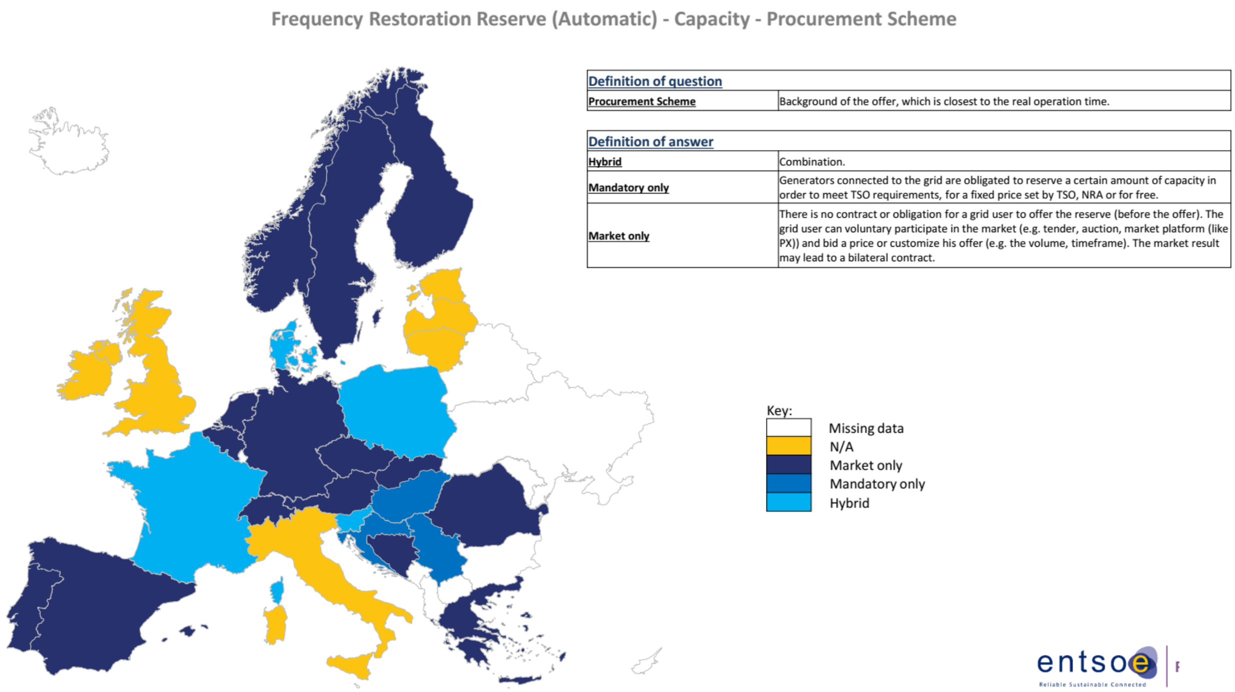


Figure 15 aFRR capacity settlement rule

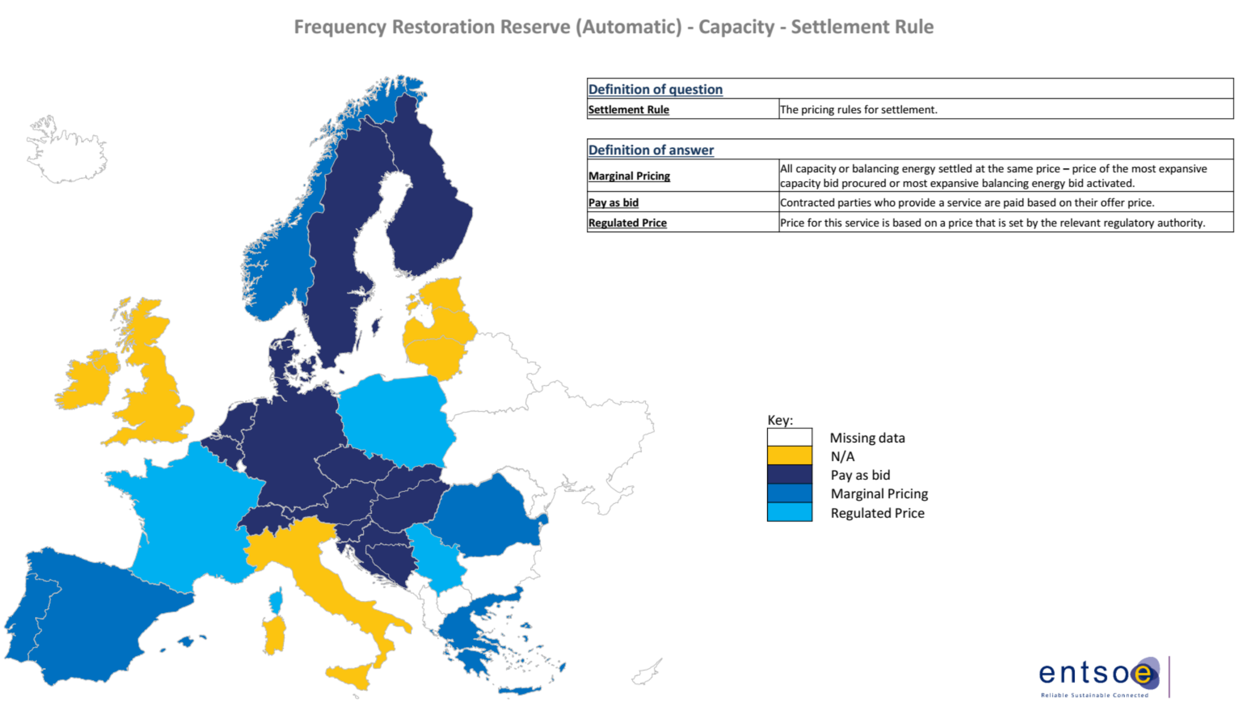
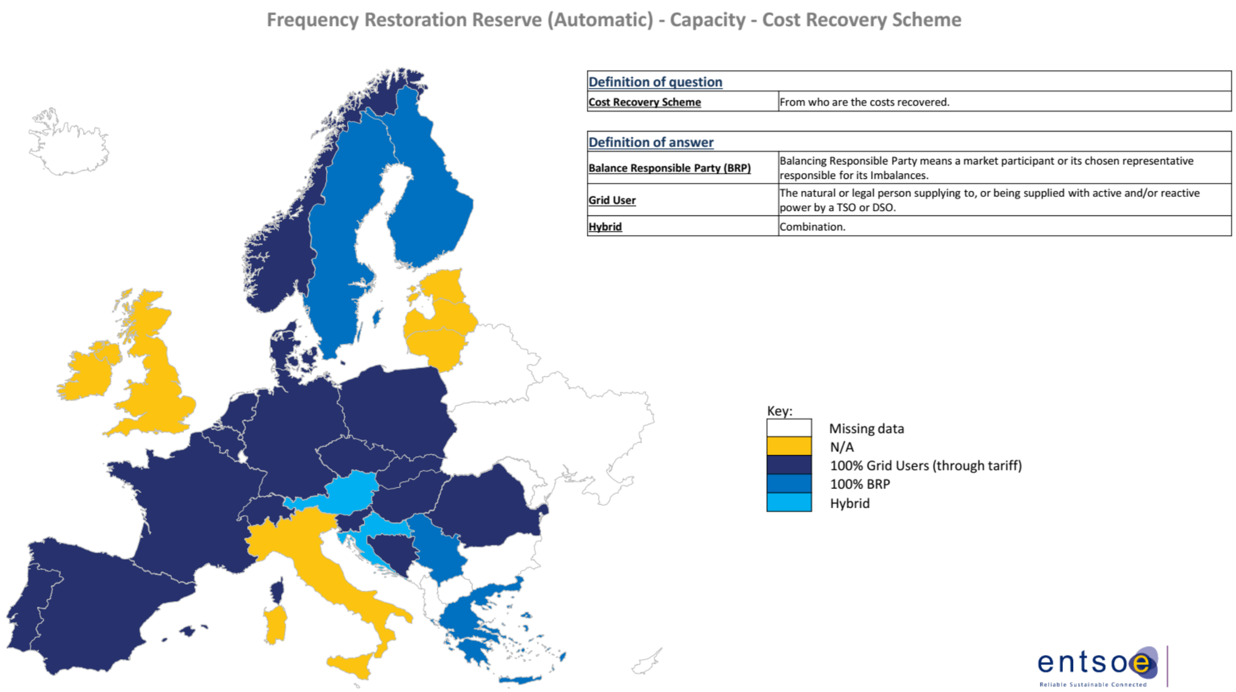


Figure 16 aFRR capacity cost recovery scheme



3.1.3. Manual frequency restoration reserve (mFRR)

Figure 17 Using mFRR in Europe

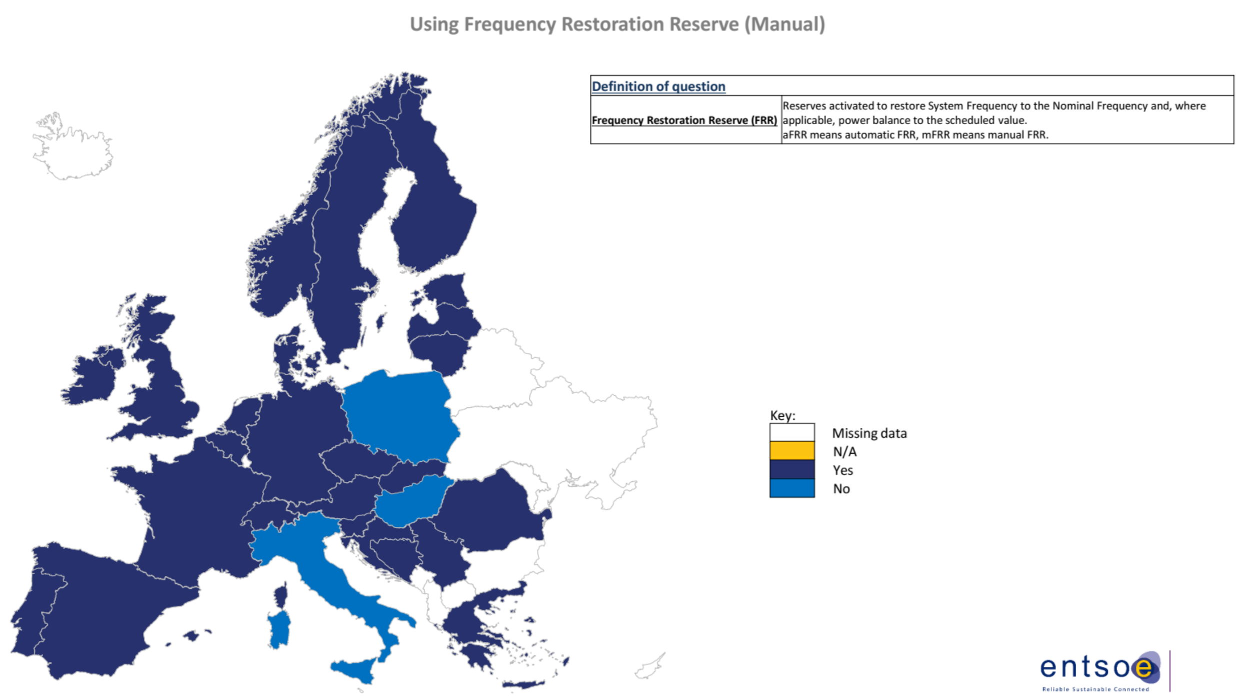


Figure 18 mFRR capacity procurement scheme

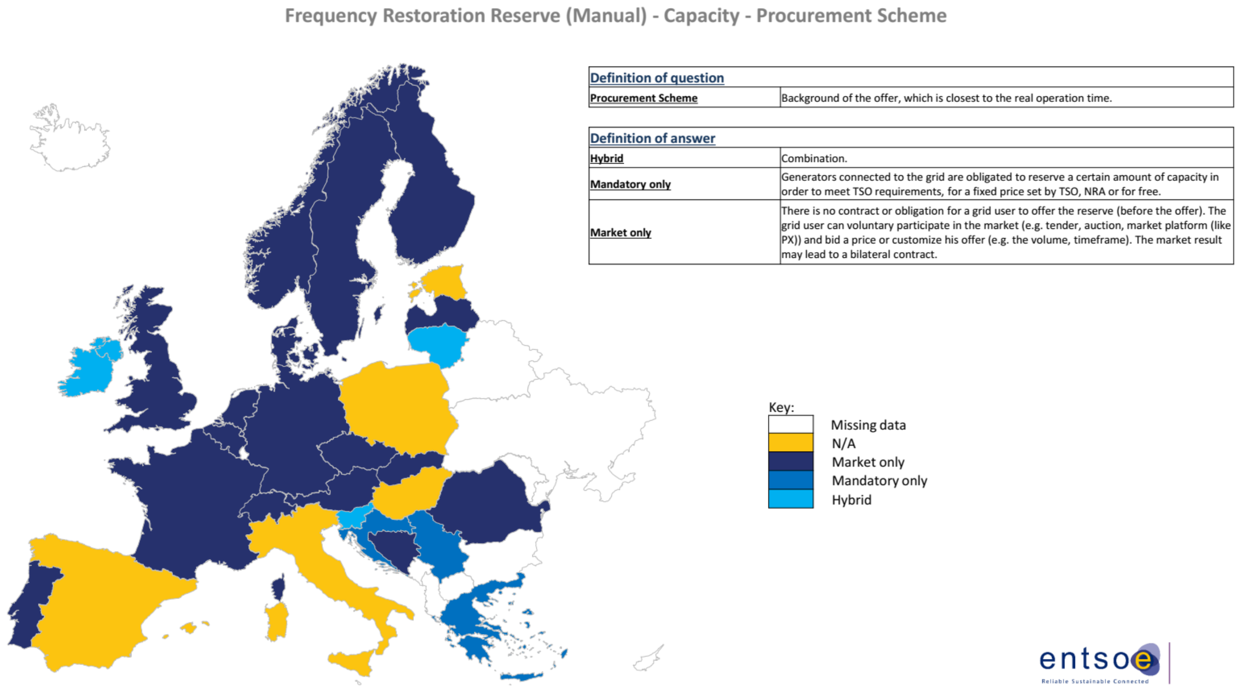


Figure 19 mFRR capacity settlement rule

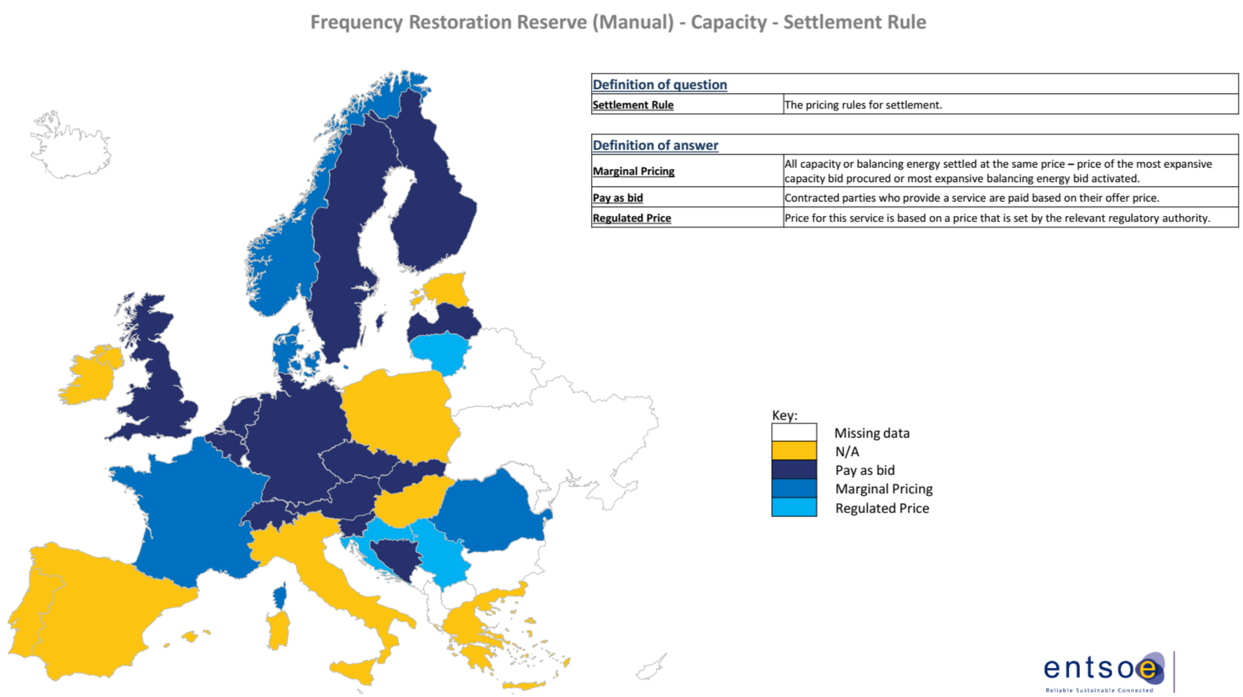
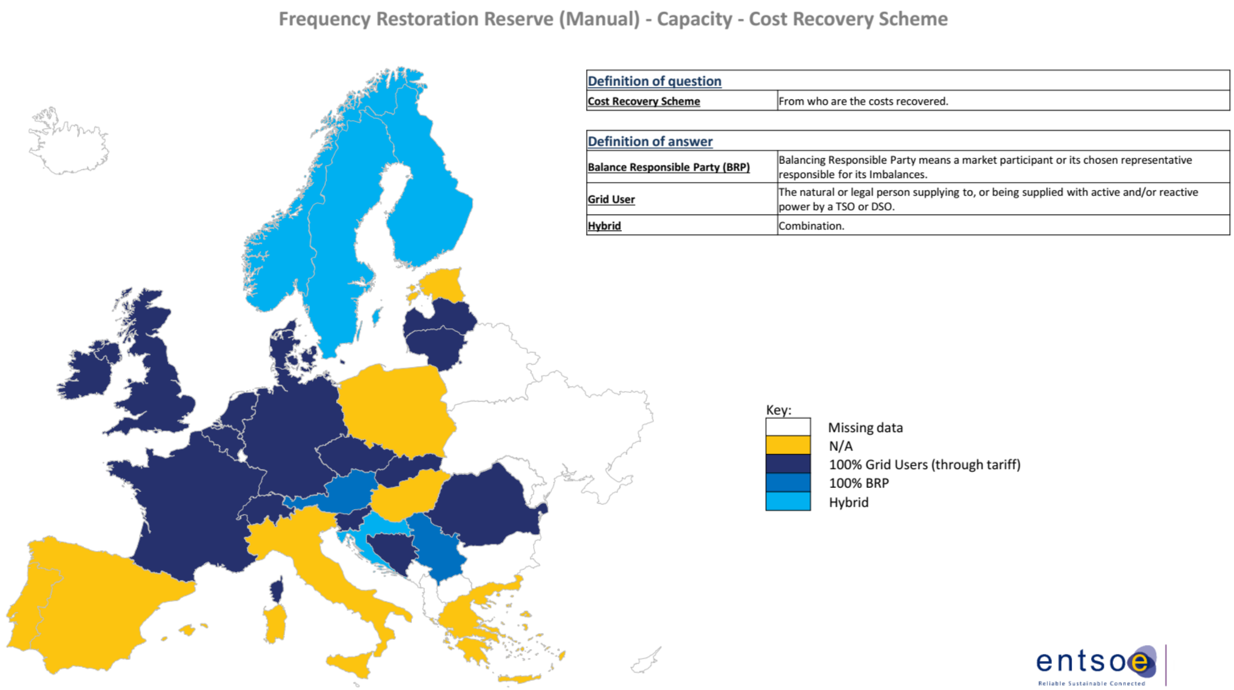


Figure 20 mFRR capacity cost recovery scheme



3.1.4. Replacement reserve (RR)

Figure 21 Using RR in Europe

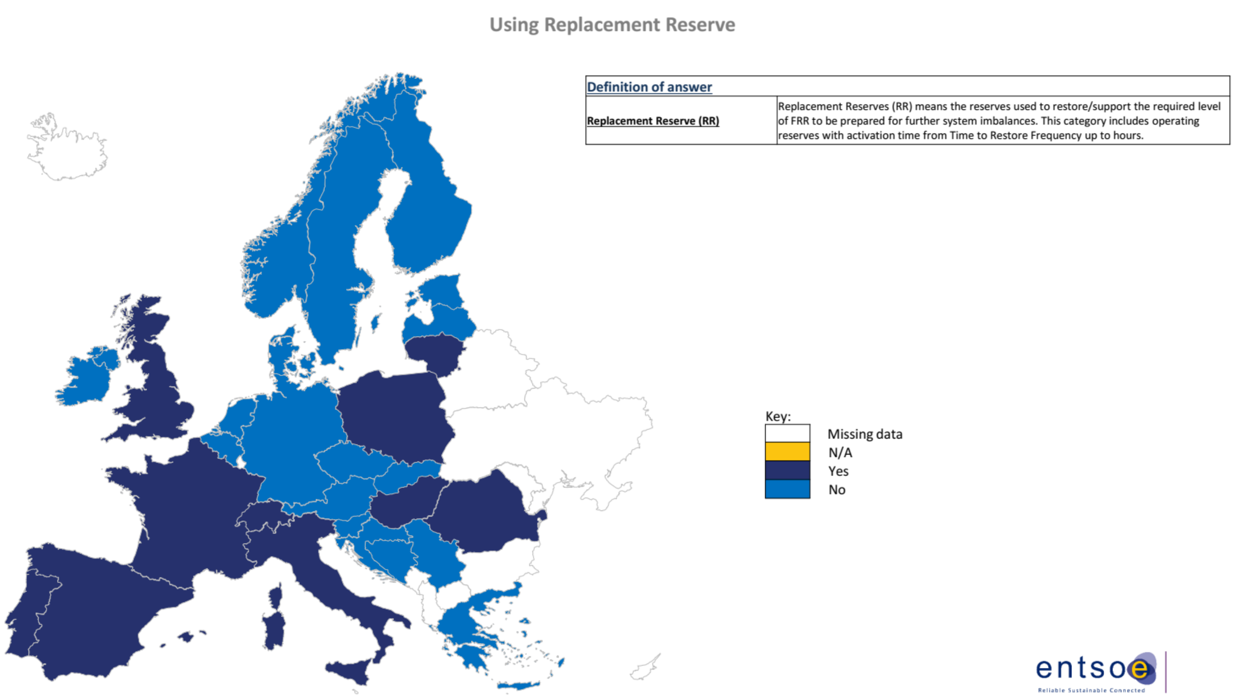


Figure 22 RR capacity procurement scheme

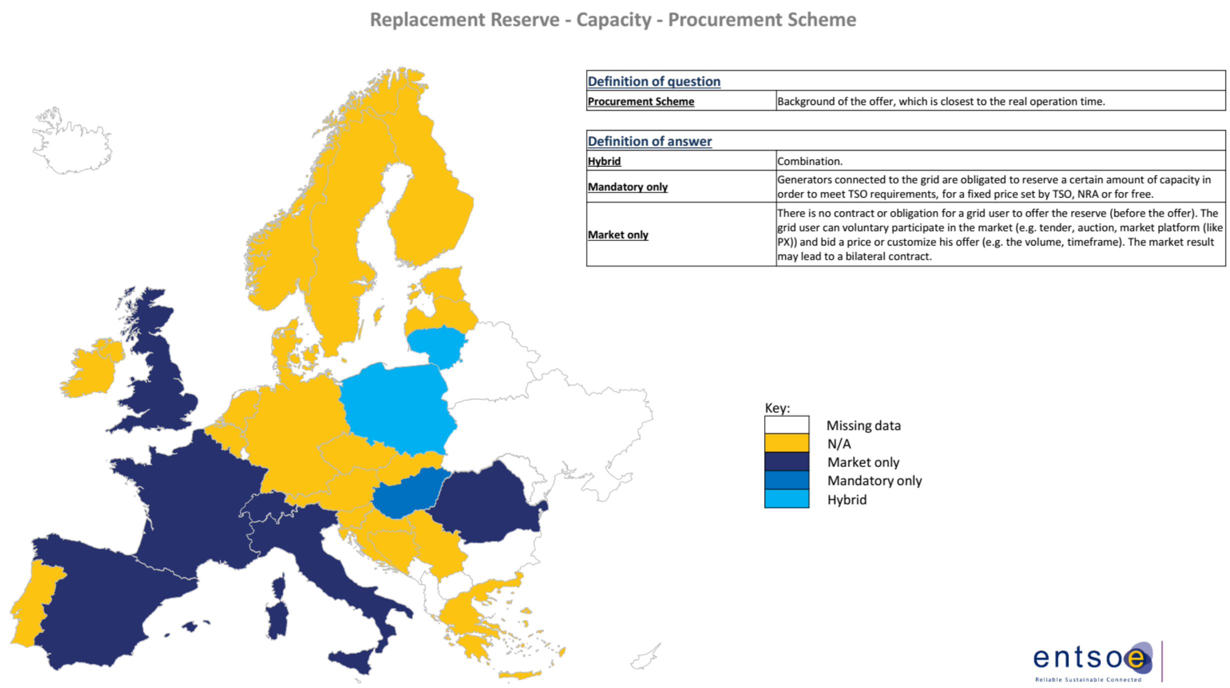


Figure 23 RR capacity settlement rule

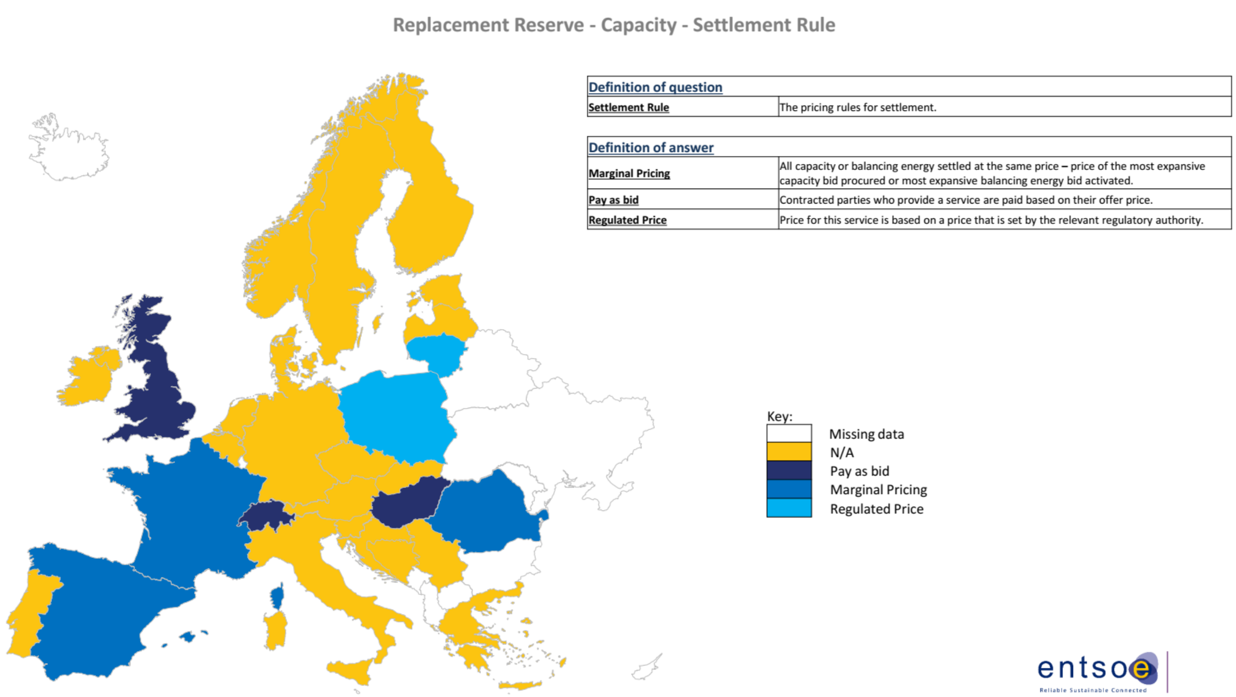
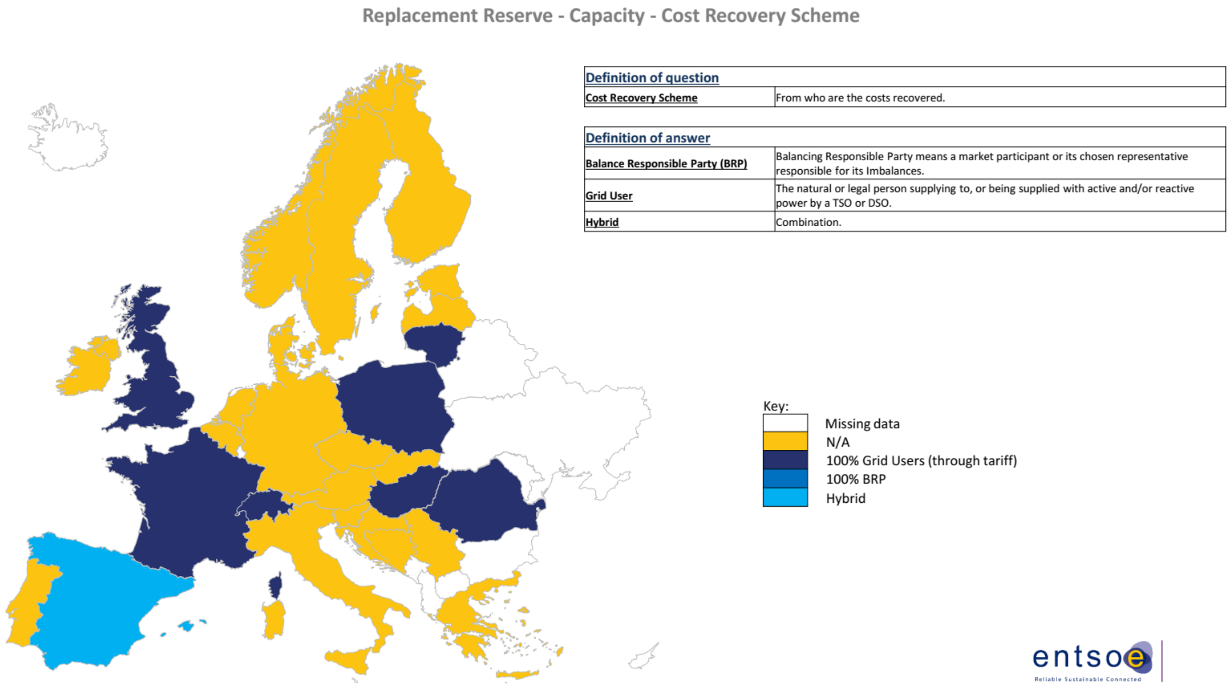


Figure 24 RR capacity cost recovery scheme



4. CROSS-BORDER TRANSMISSION CAPACITY ASSESSMENT

Before going into cross-border transmission capacity assessment it is important to note that there is a large discussion on how to a priori convince TSOs to exchange reserve (balancing) capacity [6, 7]. It seems easier to convince TSOs to exchange balancing energy than to exchange balancing capacity. The reason is very simple – it's about cost. TSOs with low-cost balancing resources will face its balancing capacity procurement cost increase if they share these low-cost resources with areas with higher-cost resources. Balancing capacity costs are usually included in the network tariff and covered by the TSOs, while balancing energy costs are covered by the BRP causing the imbalances.

Accordingly, in most of the cases in financial terms balancing energy sharing will be a zero sum for the TSOs. However, balancing capacity sharing could financially affect TSOs. This reasoning could serve as an argument to include balancing capacity cost in power system imbalance prices, but this complex topic is out of the scope of this study.

Generally, reserve capacity sharing goes one step further than the reserve capacity exchange. Namely, with reserve sharing more than one TSO takes the same reserve capacity (FCR, FRR or RR) into account to fulfil its respective reserve requirements (SOGL, Article 3 (97)). By definition reserve capacity is cross-zonal for all TSOs involved except for the connecting TSO (the TSO to which network is service provider is connected). This can also be described as common dimensioning. Reserve sharing can result with lower overall volumes of reserve capacity, which is not the case with the exchange of reserve capacity in the strict sense. However, to make reserve sharing feasible, difficult estimates need to be made about the probability that TSOs would need the same balancing resource at exactly the same moment. A very important example of reserve sharing, which is already in place around Europe, is the joint dimensioning of FCR, as given in the Chapter 3. As also discussed in [6, 7], FCR is dimensioned to cover the worst-case event in interconnected network (e.g. tripping of the largest generator unit or power infeed). Therefore, FCR is dimensioned at the scale of the synchronous area with a predefined distribution: each control area (or in this case TSO) should contribute to total FCR proportionally to its share in production/consumption for full previous year.

Imbalance netting and the exchange of balancing energy are going to be ***obligatory****. On the other hand, the exchange of reserve (balancing) capacity and reserve sharing are* ***voluntary*** *initiatives between two or more TSOs (GLEB, Art. 33(1) and 38(1)). However, a* ***balancing report*** *is also obligatory, and it should be published at least every 2 years by each TSO. In this report the opportunities for the reserve capacity exchange and reserve capacity sharing should be analysed, as well as an explanation and a justification for the procurement of reserve capacity without reserve capacity exchange or reserve capacity sharing (GLEB, Art.60(2.e- f)).*

In other words, practically it is already obligatory for the TSOs not only to implement cross-border imbalance netting and balancing energy exchange, but also to exchange balancing capacity and share the reserve capacity. If the TSOs are not implementing balancing capacity exchange and reserve sharing, then they will need to prove that their approach without cross-border exchanges is better and financially justified.

Cross-border transmission capacity allocation is a key precondition for exchange of balancing capacity and reserve sharing between the TSOs. Available cross-border (cross-zonal) transmission capacity should be allocated in advance or remaining cross-zonal capacity (after intraday gate closure) should be used for balancing purposes. Legislative framework is quite clear about it as well, as follows.

> *GLEB Article 36 (2.c) and 38(5) provisions define that it is allowed to allocate cross-zonal capacity for the exchange of balancing capacity or reserve sharing.*
>
> *GLEB Article 38 (4) provision defines that cross-zonal (or cross-border) transmission capacity allocated for the exchange of balancing capacity or reserve sharing will be used exclusively for FRR and for RR.*

As defined in GLEB Article 40 (1.d), 41 (2) and 42 (2), allocated cross-zonal transmission capacity will be limited depending on the way the reserved capacity is calculated.

In accordance to GLEB Article 38 (8) all TSOs exchanging balancing capacity or reserve sharing will regularly assess whether the cross-zonal capacity allocated for the exchange of balancing capacity or reserve sharing is still needed for that purpose.

Capacity allocation for the reserve capacity exchange or sharing is a stochastic problem as described in [6, 8]. In other words, the power system regime, balancing energy needs and cross-border transmission capacity availability are practically independent variables with high level of uncertainty. It means it is difficult to estimate the optimal volume and direction of the cross-border transmission capacity to be reserved for reserve capacity exchange or reserve capacity sharing. GLEB defines three methods to allocate cross-zonal capacity for the purpose of the exchange of reserve capacity exchange or reserve capacity sharing:

1. co-optimized allocation process,
2. market-based allocation process and
3. allocation process based on economic efficiency analysis.

The details on these three methods for cross-zonal transmission capacity allocation are given as follows:

1. ***Co-optimized allocation process:*** this method is based on a comparison of the **actual** market value

   of cross-zonal transmission capacity for the reserve capacity exchange or reserve capacity sharing and the **actual** market value of cross-zonal capacity for the exchange of energy (GLEB, Art. 40(2)). Allocation of cross-zonal transmission capacity for the reserve capacity exchange or reserve capacity sharing is done simultaneously with the capacity allocation for the exchange of energy. This method shall apply for the reserve capacity exchange or reserve capacity sharing with a contracting period of not more than 1 day and where the contracting is done not more than 1 day in advance of the provision of the balancing capacity (GLEB, Art. 40(1)).

2. ***Market-based allocation process:*** this method is based on a comparison of the **actual** market value of cross-zonal transmission capacity for the reserve capacity exchange or reserve capacity sharing and the **forecasted** market value of cross-zonal capacity for the exchange of energy, or on a comparison of the **forecasted** market value of cross-zonal capacity for the reserve capacity exchange or reserve capacity sharing, and the **actual** market value of cross-zonal capacity for the electricity exchange (GLEB Article 41 (3)). Where:

   - actual market value of cross-zonal capacity for the reserve capacity exchange will be calculated based on reserve capacity bids submitted to the capacity procurement optimization function (GLEB Article 39(3))
   - actual market value of cross-zonal capacity for the reserve sharing will be calculated based on the avoided costs of procuring balancing capacity (GLEB Article 39(4))
   - actual market value of cross-zonal capacity for the electricity exchange will be calculated based on the bids of market participants in the day-ahead markets, and take into account, where relevant and possible, expected bids of market participants in the intraday markets (GLEB Article 39(2))

3. ***Allocation based on economic efficiency analysis:*** this method is based on a comparison of the **forecasted** market value of cross-zonal capacity for the reserve capacity exchange or reserve capacity sharing, and the **forecasted** market value of cross-zonal transmission capacity for the electricity exchange (GLEB Article 42 (3)). As defined in GLEB Article 39 (5) the forecasted market value of cross-zonal transmission capacity for the exchange of energy between bidding zones shall be calculated based on the expected differences in market prices of the day-ahead and, where relevant and possible, intraday markets between bidding zones. Cross-zonal capacity is reserved before the transmission capacity auction for the exchange of energy takes place. This method applies for the reserve capacity exchange or reserve capacity sharing with a contracting period of more than one day and where the contracting is done more than one week in advance of the provision of the balancing capacity (GLEB Article 42 (1)).

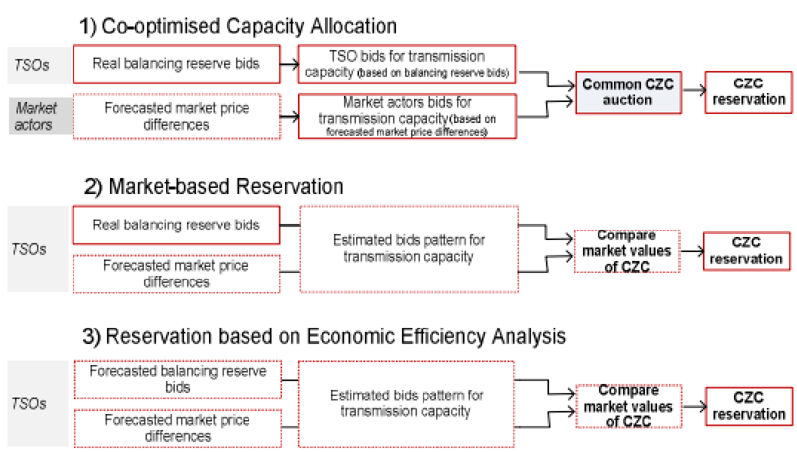
   Cross-zonal transmission capacity can be reserved just before or just after allocation for the electricity exchange. This method applies for the reserve capacity exchange or reserve capacity sharing with a contracting period of not more than 1 day and where the contracting is done not more than 1 day in advance of the provision of the balancing capacity (GLEB, Art. 41(1)).

Basic elements and a summary of the three methods is given in the following Table and Figure. Clearly, co-optimized allocation process is the most advanced method, integrating best cross-zonal transmission capacity allocation for the reserve capacity exchange or reserve capacity sharing with the capacity allocation for the energy exchange.

Table 4. Basic elements of three methods for cross-zonal transmission capacity allocation

No.	Method name	Method based on comparison between		Timing allocation vs timing of the allocation for the electricity exchange	Method application	
		Market value of the electricity exchange	Market value of the balancing capacity exchange or reserve sharing		Contracting period	Time lag between contracting and reserve activation
1	Co-optimized allocation process	Actual	Actual	Simultaneous	<=1 day	<=1 week
2	Market-based allocation	Forecasted/ actual	Actual/forecasted	Just before/after	<=1 day	<=1 week
3	Economic efficiency analysis	Forecasted	Forecasted	Before	>1 day	>1 week

Figure 25 Basic elements of cross-zonal transmission capacity allocation (Source: ENTSO-e, EnC)



In GLEB the preferred approach for cross-zonal transmission capacity allocation for reserve capacity exchange and sharing is the ***co-optimised allocation process****.*

The method is based on a comparison of the forecasted market value of cross-zonal capacity for the reserve capacity exchange or reserve capacity sharing, and the forecasted market value of cross-zonal transmission capacity for the electricity exchange.

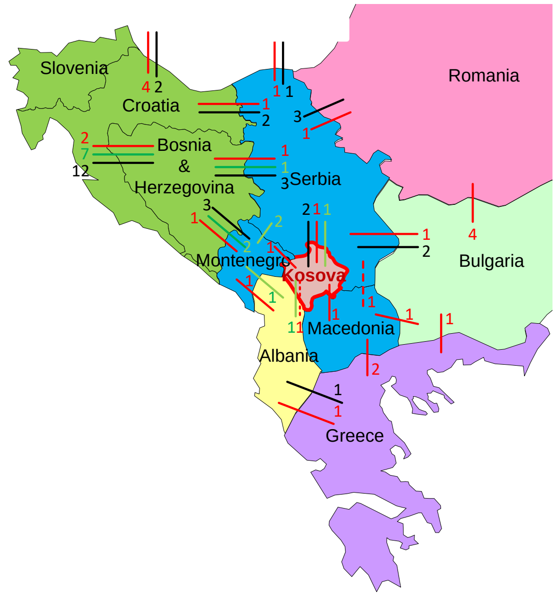
It is important to note that for Method #1 (allocation process based on economic efficiency analysis) and Method #3 (market-based allocation process) a harmonized methodology may be proposed by all TSOs (GLEB Article 41(1) and 42(1)), while for a Method #2 (co-optimized allocation process) a harmonized methodology shall be proposed by all TSOs (GLEB Article 40 (1)). The Method #2 is the one best in line with the idea to optimally integrate capacity allocation over time frames and also with the provision to procure balancing capacity on a short-term basis (GLEB, Article 32 (2.b)).

At yearly and monthly auctions transmission capacity is typically fully allocated. However, at intra-day level significant capacity is re-gained due to netting of scheduled counter-transactions allocated at yearly, monthly and daily auctions. For each border that connects TSOs intending to integrate balancing markets, the detailed analysis is needed to determine and justify the level of cross-zonal transmission capacity that needs to be reserved, considering free capacity after intra-day commercial market and also the possibility of short-term recalculation of cross-zonal transmission capacity. Since in the case of Albania and Kosovo electricity market and balancing mechanism are still in early phase, inputs for this analyses will be taken from operational experience and expert estimations.

4.1. Regional specifics

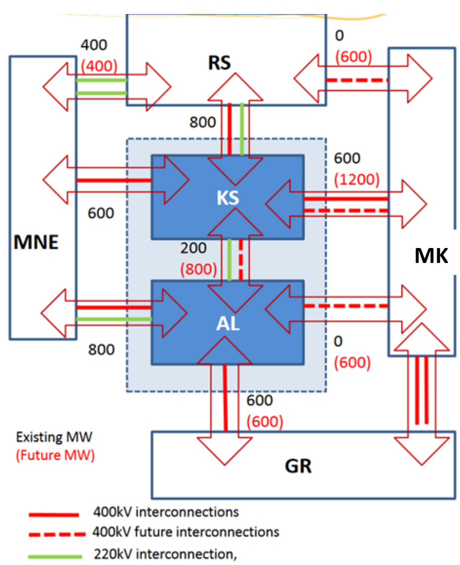
Power systems in South East Europe are quite well connected, as shown on the following figure (different colors represent LFC blocks). Currently, Kosovo has 7 interconnection lines, Albania 5 interconnection lines, while new OHL 400 kV Kosovo – Albania is still out of operation. Other neighboring countries are also very well connected. It enables not only electricity exchange and market activities, but it is also important infrastructure for operational security and reserve exchange and sharing.

Figure 26 Power system interconnections in South East Europe (red-400 kV, green–220 kV, black–110 kV line)



Total installed transmission capacity of Kosovo interconnection lines is 5860 MVA, while total net transfer capacities (NTC) are usually around 2200 MW, as given on the following figure. Net transfer capacity on all Albanian borders is around 1800 MW. With new 400 kV line in operation it will additionally increase NTC on Kosovo-Albania border for about 600 MW in both directions. It will significantly increase available cross-border capacity not only for market activities, but also for reserve capacity exchange and sharing between two systems.

Figure 27 NTC values in the region



The following Table shows system peak loads, total installed generation capacities and the largest generating units in the regional power systems. Since power system reserve should cover the outage of the largest generating unit in the system (dimensioning incident), it is important to know the share of the largest unit in total generation capacity and in the peak load.

Table 5. Peak loads, total installed generation capacities and the largest generating units in the regional power systems

Country	Peak load (MW)	Total installed generation capacity (MW)	The largest generation unit (MW)	The largest unit share in the peak load (%)	The largest unit share in total generation capacity (%)
Albania	**1500**	**1823**	**150 (HPP Komani)**	**10**	**8**
Bosnia-Herzegovina	2200	3964	300 (TPP Ugljevik, TPP Stanari)	14	8
Bulgaria	8000	12300	1000 (NPP Kozloduy)	13	8
Croatia	3100	4094	696/2 (NPP Krsko)*	10	7
Kosovo	**1100**	**1217**	**275 (TPP Kosovo B1, B2)**	**25**	**23**
Greece	9700	16500	400 (TPP Megalopolis)	4	2
Macedonia	1600	1613	233 (TPP Bitola)	15	14
Montenegro	700	827	210 (TPP Pljevlja)	30	25
Slovenia	2100	3268	696/2 (NPP Krsko)*	33	21
Romania	9000	21800	750 (NPP Cernavoda)	8	3
Serbia	6500	7190	620 (TPP N.Tesla B1, B2)	10	9

**NPP Krško is 50% owned by Croatia and Slovenia*

In average, the largest unit share in total generation capacity in the region is 12%, while in Kosovo it is 23% and in Albania 8%. Not all generation units are not always fully available due to its reliability or hydro conditions. So, in operational practice these values (shares) are even higher, making it even more difficult to keep the reserve and run the market at the same time.

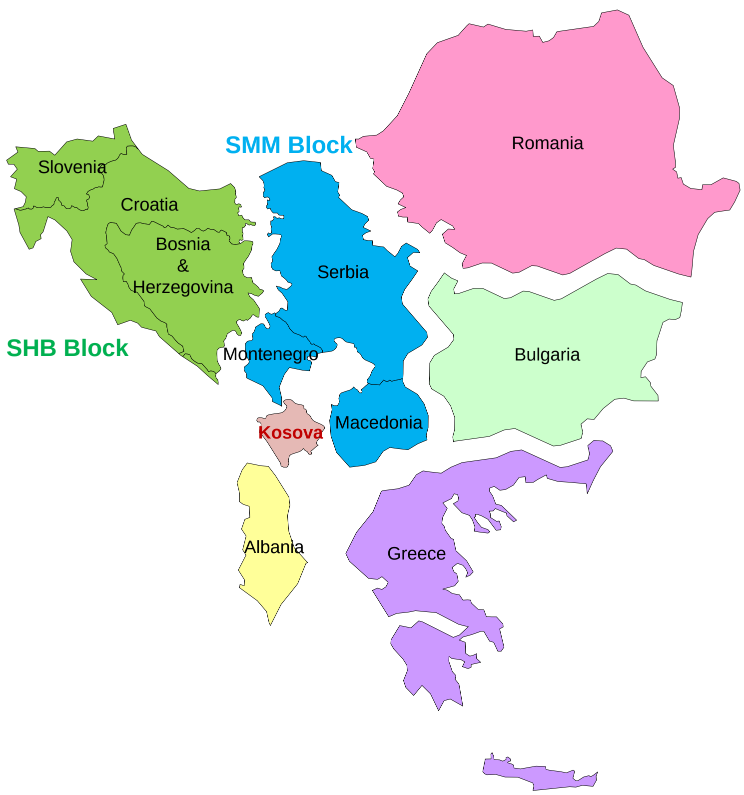
In average, the largest generating unit share in the power system peak load in South East Europe is 16%, while in Kosovo it is 25% and in Albania 10%. Clearly, Kosovo and Montenegro are facing extreme conditions for keeping adequate reserve capacities to cover dimensioning incidents.

Reserve capacity needs in both countries is large, compared to overall existing generation capacity and the peak load. Common reserve dimensioning and reserve sharing would significantly decrease the level of reserve capacity needs in both systems without jeopardizing system operation. It assumes release of some generation capacity for market activities, which will result with significant social welfare and economic benefit for the final consumers.

4.2. Status of Albania and Kosovo as LFC area and/or block

The main precondition for implementation of reserve sharing/exchange methods is clear status of Kosovo and Albania as ENTSO-e LFC area and LFC block. Currently, the status of LFC blocks in the region is shown on the following figure. Albanian OST is full member of the ENTSO-e since 2017. Albania is individual LFC block without participation in any other TSOs in this LFC block, while Kosovo TSO is still not member of the ENTSO-e, so Kosovo is formally still not LFC area. After fulfillment of all technical requirements and ENTSO-e – KOSTT Connection Agreement signed in October 2015, Kosovo is still waiting to be taken out from Serbian LFC block and formally recognized as independent LFC area.

Figure 28 LFC areas and blocks in South East Europe

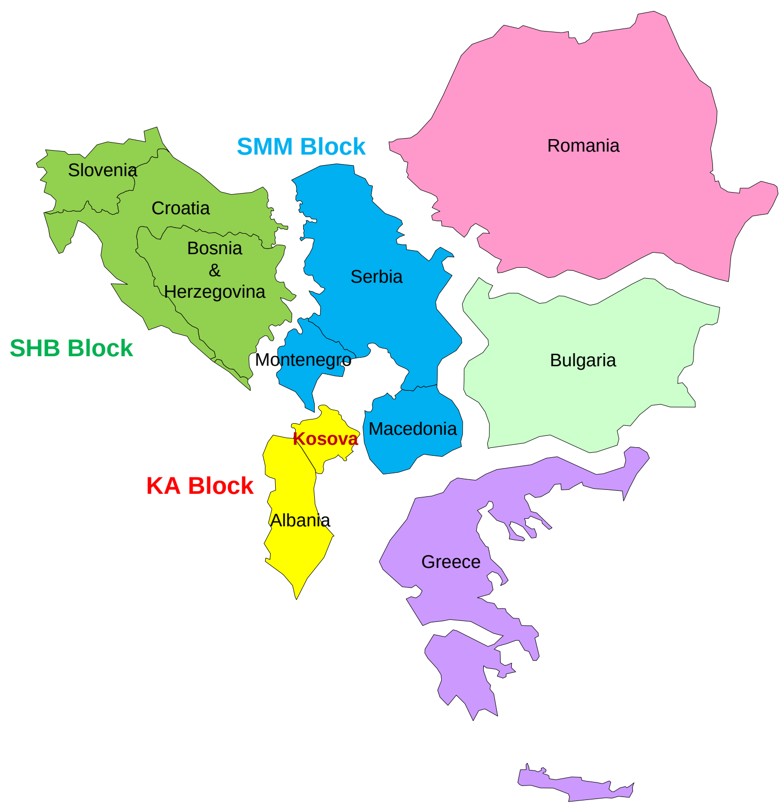


If Kosovo and Albania are in the same LFC block, then, by definition, the possibilities for reserve exchange/sharing is much higher than in the case where Kosovo and Albania are not in the same LFC block.

Without going into formal and technical requirements, from the reserve capacity sharing point of view it is recommended that Albania and Kosovo form single LFC block. In the same LFC block Albania and Kosovo wouldn't have any limit for common dimensioning and reserve capacity geographical location, while in case of two different LFC blocks, reserve capacity sharing would be limited that 30%, and reserve exchange to 50% of the dimensioning incident capacity should be located within each country.

In that case LFC blocks in the region will be organized as given on the following figure.

Figure 29 LFC areas and blocks in South East Europe with new KA LFC block



4.3. Current practice in Kosovo and Albania

4.3.1. Reserve capacity and balancing energy in Kosovo and Albania

In Kosovo KOSTT has no contracts for mFRR and RR capacity. KOSTT signed aFRR contract with OST, but it is still not implemented. However, there are contracts in place for purchasing balancing energy.

In Albania OST has a bilateral contract with KESH for FRR and RR capacity, as well as for balancing energy. The contract is signed in March 2018 with the only one service provider - KESH. The following Table shows balancing service contracts and costs in Albania and Kosovo.

Table 6. Balancing service contracts and costs in Albania and Kosovo (source: KOSTT and OST)

Year 2018	FRR contracted	RR contracted	Balancing energy contracted	Annual reserve capacity cost (mil.€)	Annual balancing energy cost – TSO paid (mil.€)	Annual balancing energy cost – TSO received (mil.€)
Kosovo	No	No	Yes	0	6,7	0,5
Albania	Yes	Yes	Yes	10,7*	5,1	4,9

*March-Dec 2018

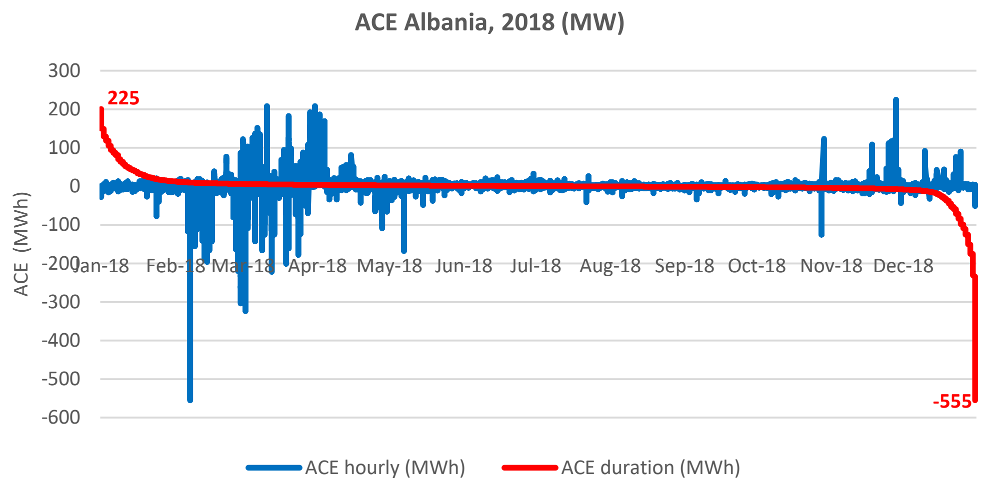
One of the most important indicators of system operation and balancing mechanism is area control error (ACE). ACE is defined as the sum of the power control error ('ΔP', that is the real-time difference between the measured actual real time power interchange value ('P') and the control program ('P0') of a specific LFC area or LFC block) and the frequency control error ('K*Δf', that is the product of the K-factor[7] and the frequency deviation of that specific LFC area or LFC block), where the area control error equals ΔP+K*Δf.

For the purpose of this study the authors needed detailed inputs on ACE as well as scheduled and realized cross-border flows. However, input data on ACE were delivered by the TSOs in three different sets (see Annex 1 for details), while for the cross-border flows just scheduled values were used.

ACE of Albanian power system (last set of data) is shown on the following Figure. The Figure is based on the input data given by OST and it refers to 15-min time series for 2018. Average ACE was almost zero: 0.77 MW, while total range was generally very narrow, with few short extreme periods between –225 MW and +555 MW. **ACE of Albania should be inside the range of +/-20 MW and, according to input data delivered by OST, it was achieved in 89.4% of the time in 2018.**

[7] K-factor is a value expressed in megawatts per hertz (MW/Hz), which is as close as practical to, or greater than the sum of the auto-control of generation, self-regulation of load and of the contribution of frequency containment reserve relative to the maximum steady-state frequency deviation.

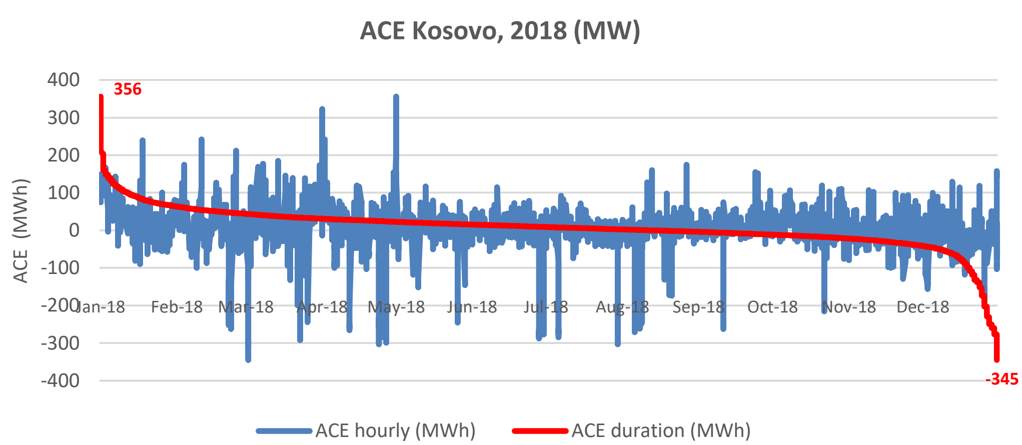
Figure 30 Area control error (ACE) for Albania 2018 (source: OST)



As some of the TSOs use above mentioned probabilistic approach with 99% threshold, which is requirement from SOGL, this would imply that OST would have needed +133 MW of positive FRR and – 177 MW of negative FRR to cover area control error. Taking into account dimensioning incident, the largest generator in HPP Koman, OST needs +150 MW of positive FRR and -100 MW[8] of negative FRR, which represents the largest load in the system (Kurum Steel).

Very different situation is found in ACE for Kosovo power system for 2018, as shown on the following Figure. The Figure is based on the input data given by KOSTT and it refers to the 1-hour time series for 2018.

Figure 31 Area control error (ACE) for Kosovo 2018 (source: KOSTT)

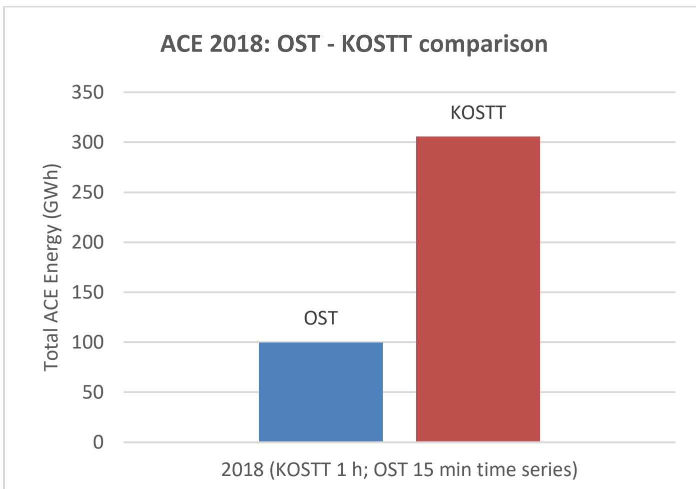


[8] Kurum Steel factory grid connection capacity is set to 200 MW (2 furnance with 100 MW each), but only one is in operation

Again, as some of the TSOs use above mentioned probabilistic approach with 99% threshold, which is requirement from SOGL, this would imply that KOSTT would have needed +166 MW of positive FRR and – 260 MW of negative FRR to cover area control error. Taking into account dimensioning incident (the largest generator TPP Kosovo B) KOSTT needs +275 MW of positive FRR and -85 MW[9] of negative FRR, which represents the largest load in the system (Feronikal).

It is obvious that there is large discrepancy between Kosovo and Albania ACE values for 2018. In total ACE in Kosovo in 2018 was 3 times higher than in Albania (305 GWh : 100 GWh), as shown on the following Figure. These values represent sum of absolute values of total positive and total negative ACE in 2018.

Figure 32 Comparison between sum of absolute ACE values for 2018 in Kosovo and Albania



Not going into the reasons for such a large discrepancy, if we assume that Kosovo and Albania are operating together, then through imbalance netting common ACE would be lower than the sum of individual ACEs, as given on the following two figures.

[9] For 2019 contracted capacity for Feronikal is decreased from 85 MW to 50 MW. It will decrease system reserve capacity needs.

Figure 33 Area control error (ACE) for Kosovo and Albania together in 2018

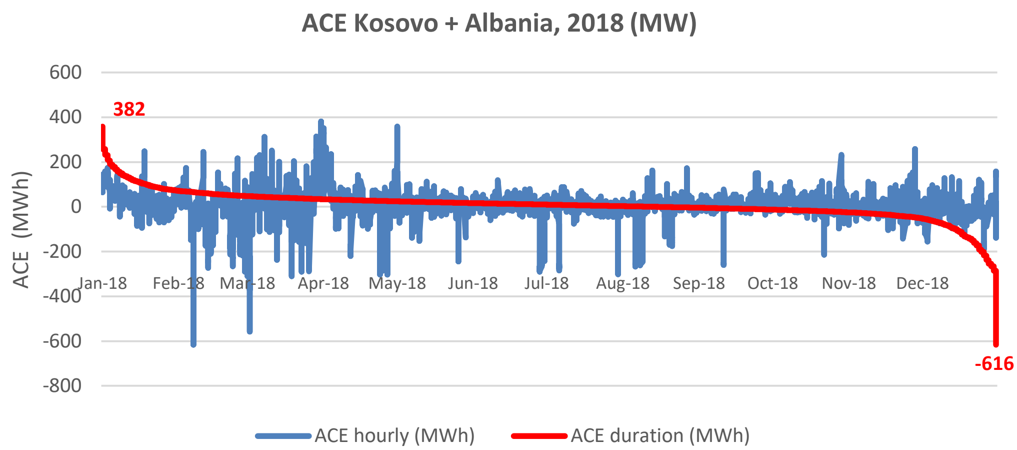
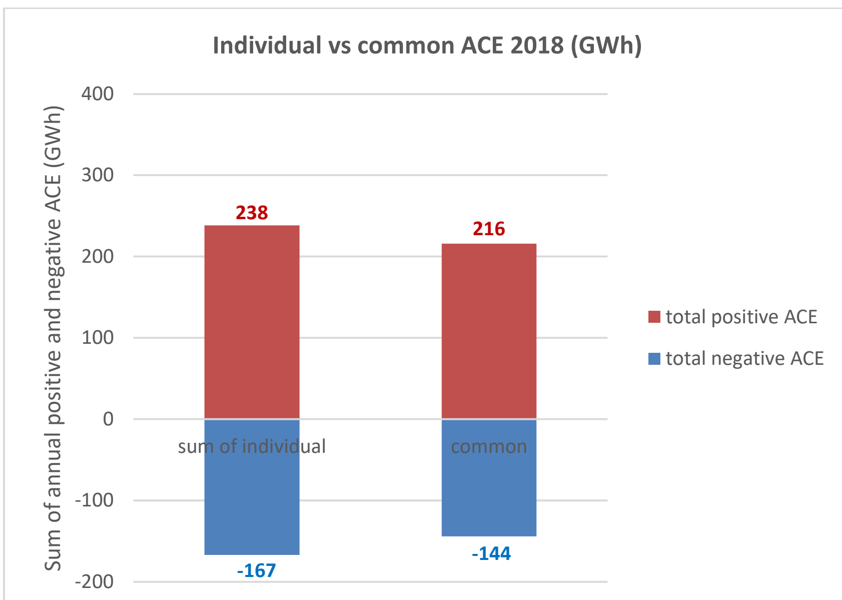


Figure 34 Comparison between sum of individual ACE values and common ACE value for 2018 in Kosovo and Albania



Clearly, total sum of individual ACEs in 2018 was 405 GWh (167 GWh of negative and 238 GWh of positive system error). With netting approach part of ACEs will be eliminated resulting with slightly lower total common ACE: 360 GWh (144 GWh of negative and 216 GWh of positive system error). This assumes reduction of 11.1%, or 13.5% lower negative and 9.5% lower positive ACE, as given in the following table.

Table 7. Comparison between individual and common ACE of Kosovo and Albania in 2018

AREA CONTROL ERROR IN 2018	NEGATIVE ACE (GWh)	POSITIVE ACE (GWh)	TOTAL ACE (GWh)
Kosovo	-120	185	**305**
Albania	-46	53	**100**
Sum of INDIVIDUAL ACEs	-167	238	**405**
COMMON ACE Kosovo+Albania	-144	216	**360**
difference between sum of individual and common ACE (GWh)	-23	23	**45**
difference of the sum of individual ACEs (%)	13.5	9.5	**11.1**

If we assume that the price of electricity used to cover ACE is 70 €/MWh, this would assume savings of about 3.2 mil.€/year.

As shown on the previous figures and table, **75% of sum of individual ACE in 2018 appeared in Kosovo power system**. Therefore, eventual savings in ACE due to common approach will mainly affect Kosovo system. By definition given in the Balancing Codes *secondary control reserve is an additional amount of operating reserve sufficient to reduce area control error (ACE) automatically by means of secondary controller and contribute – particularly after a major contingency such as the loss of a large generating unit – to the restoration of the frequency to its set value in order to restore the system to its previous secure state.* This would imply adequate reserve capacity and balancing energy to cover ACE, which assumes certain costs.

To resolve these situations of large area control errors of Albanian and Kosovan power system it is recommended to take the following actions:

1. *to introduce intraday market and enable BRPs (and TSOs, if BRPs do not perform intraday portfolio balancing) to buy/sell electricity from/to local and regional traders on the market price, without capacity payments. It is usual that balancing energy from reserve capacity is more expensive than electricity market price. However, in the case that TSO is participating here, then its costs must be covered by the network tariff or be allocated through balancing mechanism on the BRPs.*
2. *to introduce higher incentives/penalties to all balancing responsible parties (BRPs). It will certainly decrease BRPs planning error and balancing energy needs*
3. *to sign TSO-TSO cross-border emergency delivery contracts using transmission reliability margin (TRM) on the cross-border capacities. It is usually used when there is a lack of energy in the LFC block. These contracts are used as the last resort measure and are usually characterised with high electricity prices.*

Currently, both in Albania and Kosovo practically there is just one service provider for reserve capacity – KESH in Albania and KEK in Kosovo. However, all generators should have a chance to contribute to providing reserve capacity. Contract prices are not market-based but negotiated and/or regulated. Hungarian Power Exchange (HUPX) price is the reference price for balancing energy, while separate prices apply to reserve capacity. However, both service providers KESH and KEK occasionally struggled to provide reserve and to meet its service obligations [11]. In Albania no provider of balancing services is yet certified, but it is expected that tenders will be introduced soon, working with the International Finance Cooperation (IFC) project on the balancing market. Since imbalance settlement price is not market–based, there is no full incentive for BRPs for better balancing, nor the full cost-reflectivity to the costs of service provider. Accordingly, main driver to introduce a market-base contractual mechanism and reserve sharing is not only on the TSO side, but also on the service providers' side to enlarge their market field and potential income. Currently, ancillary services (AS) comprise about 1/7 of OST's revenue [11].

The ultimate target is to include other generators/loads in this mechanism whenever possible. OST and KOSTT have the IT infrastructure to run tenders and could also run auctions for AS with some adjustments, but investments on the generation side will be required. Generators other than KESH and KEK have never been asked to provide AS before. It is recommended to include new service providers wherever possible.

4.3.2. Remaining cross-border capacity between Kosovo and Albania

For this analysis it is also important to clarify existing principle of cross-border transmission capacity allocation between Kosovo and Albania. Currently, there are two main transmission values to be defined on Kosovo – Albania border: TRM and NTC.

Transmission Reliability Margin (TRM) is based on a statistical approach, taking into account historical values and future expectations. TRM comprises the following uncertainties:

1. Unintended deviations of physical flows during power system operation due to the physical functioning of load-frequency regulation,

2. Emergency exchanges between the TSOs to cope with unexpected unbalanced situations in real time,

3. Inaccuracies, e.g. in data collection and measurements,

4. Uncertainties in the base case used for calculation, as well as the foreseen for generation, consumption, exchange and grid topology, etc.

Currently, on Kosovo – Albania border TRM value is bilaterally agreed at the level of 50 MW. For comparison, TRM on Albanian-Montenegrin and Albanian-Greek border is set to 100 MW.

As described in ERE Annual Report [9], NTC annual value for each direction on Kosovo-Albania border is calculated considering minimum monthly value that's been used in the past three years. It is coordinated between the TSOs during November each year for the following year.

NTC monthly values are calculated and harmonized on 7th day of each month for the following month. This process is done through 3 steps:

1. 10 days before the expiration of the harmonization deadline, the national power system models are exchanged between the TSOs in agreed format. It includes active power generation shift key for increasing/decreasing the generation level as well as maintenance program data (elements out of operation) for the period under consideration.

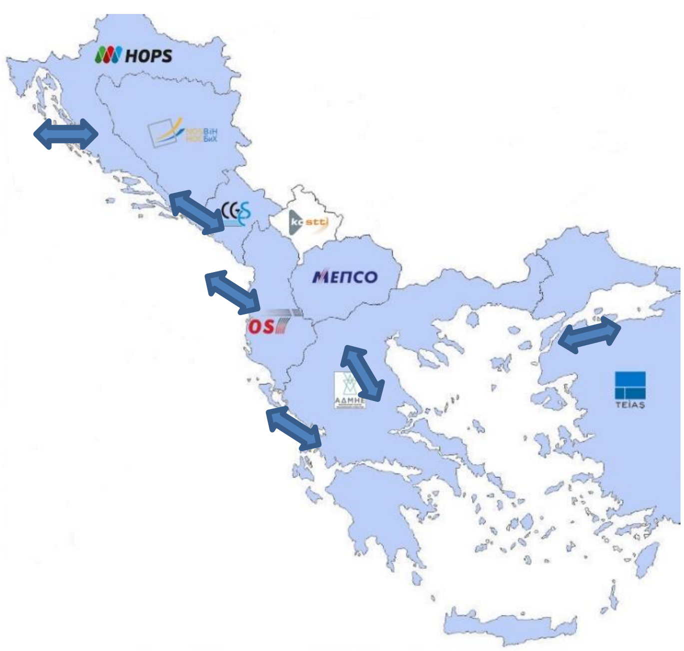
2. 5 days prior to the expiration of harmonization deadline, the calculations for TTC/NTC values are performed using commonly licensed software.

3. 2 days prior to the expiration of harmonization deadline, TTC values are determined unilaterally and exchanged. In case of inconsistency of the calculated TTC values from both sides, the parties try to agree on common value. If there's no agreement, lower TTC value is automatically accepted by both sides.

In case of significant changes of the planned power system conditions, cross-border capacities (TTC, NTC and ATC) are re-calculated, based on additional exchange of the updated inputs.

Cross-border capacity allocation for market participants in Albania is performed by the Coordinated Auction Office (SEE CAO) in Podgorica, Montenegro. However, even though KOSTT is shareholder of SEE CAO, Kosovo borders (including Kosovo-Albania border) are not allocated by SEE CAO, as shown on the following Figure.

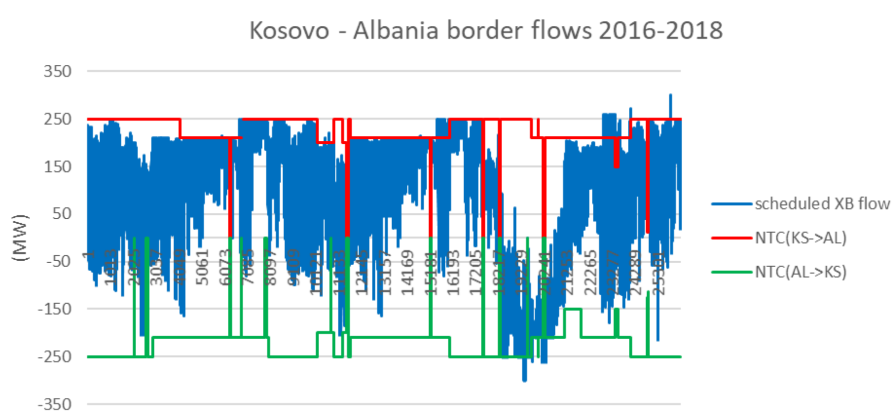
Figure 35 SEE CAO: shareholders and border allocation responsibility (source: SEE CAO)



It is interesting to calculate how much cross-border capacity is actually used on Kosovo-Albania border. Without new 400 kV line NTC value on Kosovo-Albania border is limited to around 200 – 250 MW depending on the season, relying at only one 220 kV interconnection line. Input data are taken from the ENTSO-e Transparency Platform for the time period 2016 – 2018.

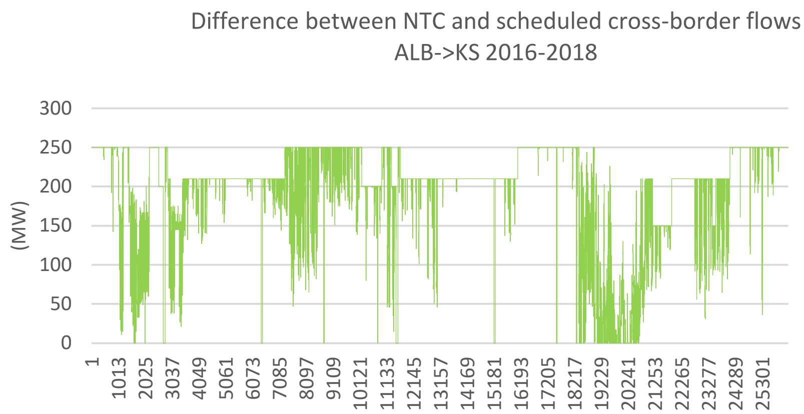
Analysis of this three-year dataset clearly shows that most of the time there is a large remaining cross-border capacity between Kosovo and Albania. In other words, in addition to the scheduled cross-border flows there are relatively large remaining cross-border capacities in both directions. The following Figure shows scheduled cross-border flows on the Kosovo-Albania border in the period 2016-2018 (26 280 hourly values) and NTC values in both directions (hourly values of forecasted transfer capacities day ahead). In given timeframe most of the time NTC (KS→ALB) values are in the range 200-250 MW (228 MW in average), while in the opposite direction NTC (ALB→KS) values are practically the same, 221 MW in average. At the same time, average scheduled cross-border flows are in the range -300 MW to 300 MW (same values in opposite directions), with the average power flow of 130 MW from Kosovo to Albania and 58 MW from Albania to Kosovo (total average of 72 MW in direction from Kosovo to Albania). Hourly data on NTC values and scheduled cross-border flows are given on the following figure.

Figure 36 Cross-border (XB) flows on Kosovo-Albania border in the period 2016 – 2018 (Source: ENTSO-e)



Clearly, there is a large amount of remaining cross-border transmission capacity that is available in both directions after scheduled flows are realized. **The following figure shows the difference between NTC values and scheduled cross-border flows in direction from Albania to Kosovo. Average remaining cross-border capacity on this border in last three-year timeframe was 192 MW.**

Figure 37 Difference between NTC and scheduled cross-border power flows in direction from Albania to Kosovo in the period 2016-2018



The same values are grouped in 50-MW lots and presented in histogram format on the following two figures. 69% of the time (18076 out of 26308 hours) remaining cross-border capacity from Albania to Kosovo is larger than 200 MW. This cross-border capacity can be used for reserve capacity exchange/sharing. In other words, theoretically, in more than 2/3 of the time (69%) Kosovo system can import reserve capacity larger than 200 MW from Albania without jeopardizing cross-border market activities.

Figure 38 Difference between NTC and scheduled cross-border power flows in direction from Albania to Kosovo in the period 2016-2018

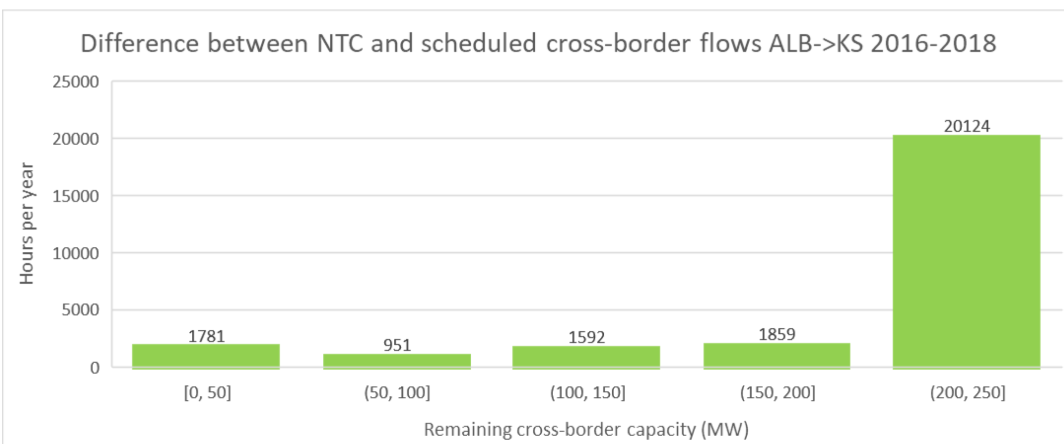
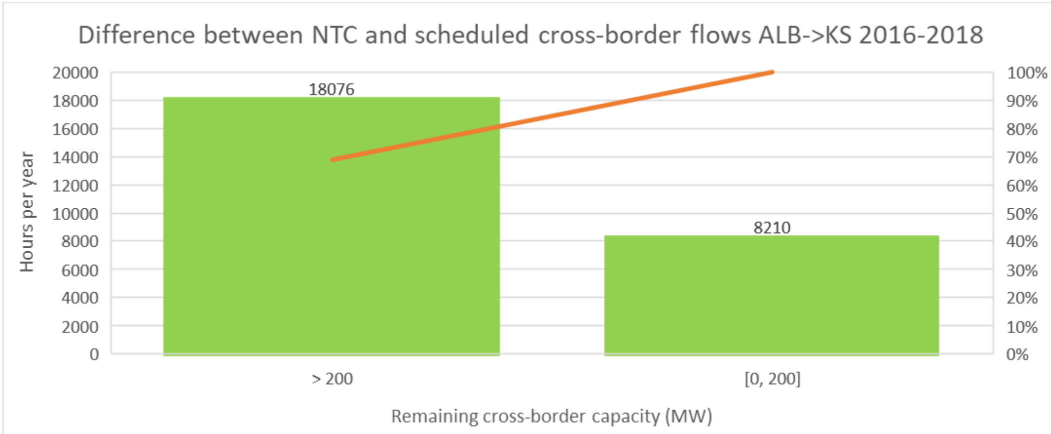
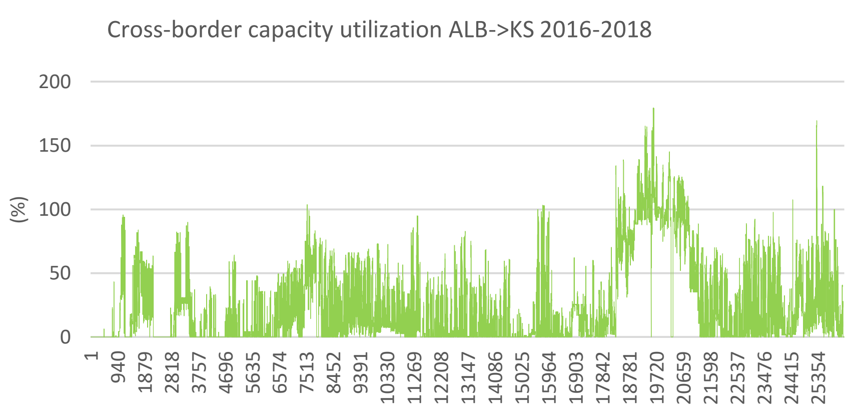


Figure 39 Difference between NTC and scheduled cross-border power flows in direction from Albania to Kosovo in the period 2016-2018



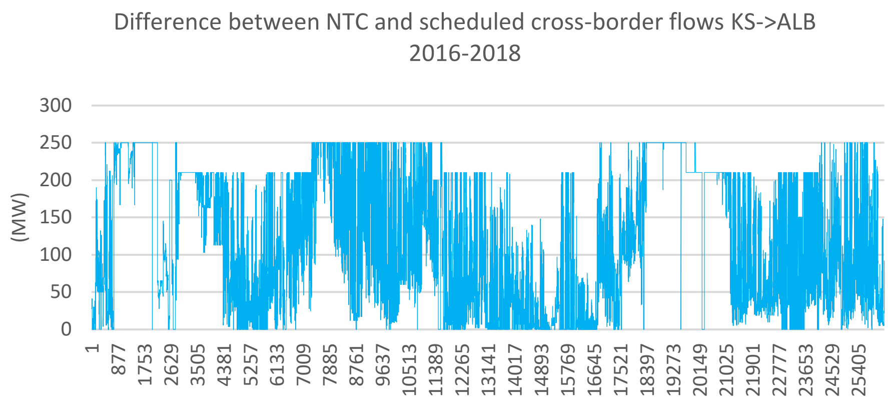
The same values can be presented as the level of utilization – share between actual cross-border flow and declared NTC value, as shown on the following figure for Kosovo → Albania direction. The average utilization level in three-year time frame was 25%.

Figure 40 Utilization of cross-border capacity in direction from Albania to Kosovo in the period 2016-2018



Slightly lower values can be found in the opposite direction on the same border, as given on the following figure.

Figure 41 Difference between NTC and scheduled cross-border power flows in direction from Kosovo to Albania in the period 2016-2018



Average difference between NTC values and scheduled cross-border flows in direction from Kosovo and Albania in the period 2016-2018 was 126 MW. The same values are given on the following two figures in histogram format.

55% of the time (14409 out of 26308 hours) remaining cross-border capacity from Kosovo to Albania is larger than 100 MW. This cross-border capacity can be used for reserve capacity exchange/sharing. In other words, theoretically, in more than 1/2 of the time (55%) Albania system can import reserve capacity larger than 100 MW from Kosovo without jeopardizing cross-border market activities. Moreover, 33% of the time (8734 out of 26308 hours) remaining cross-border capacity from Kosovo to Albania is larger than 200 MW.

Figure 42 Difference between NTC and scheduled cross-border power flows in direction from Kosovo to Albania in the period 2016-2018

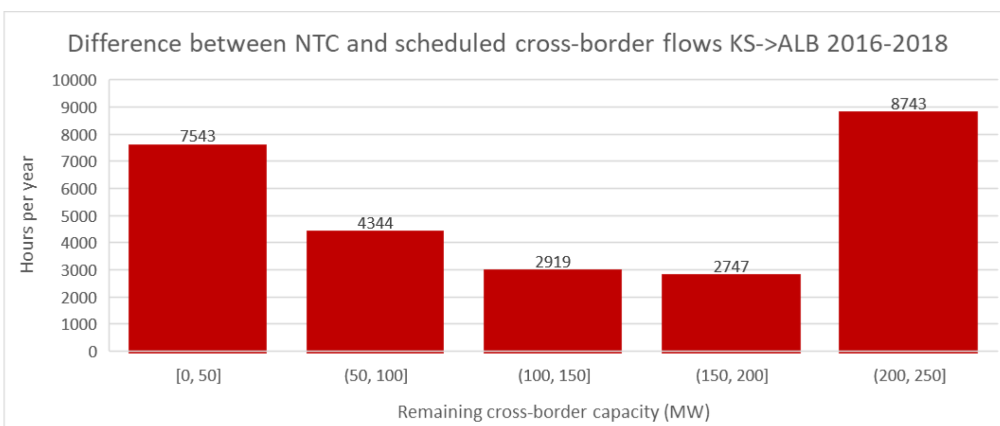
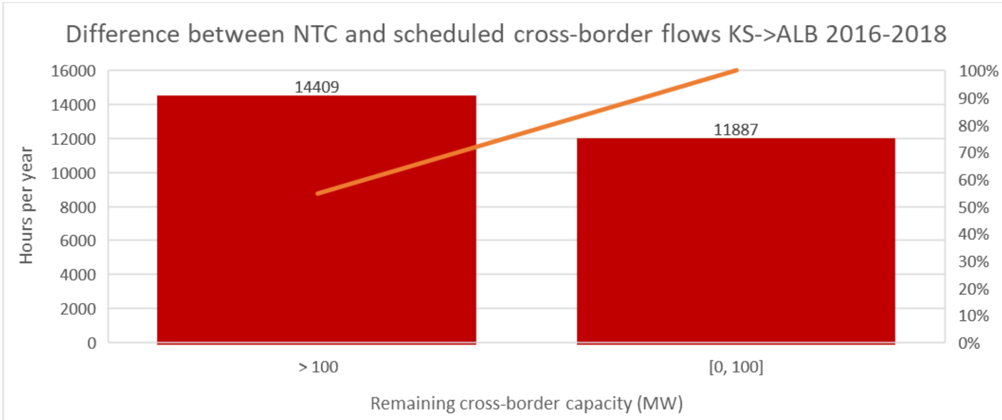
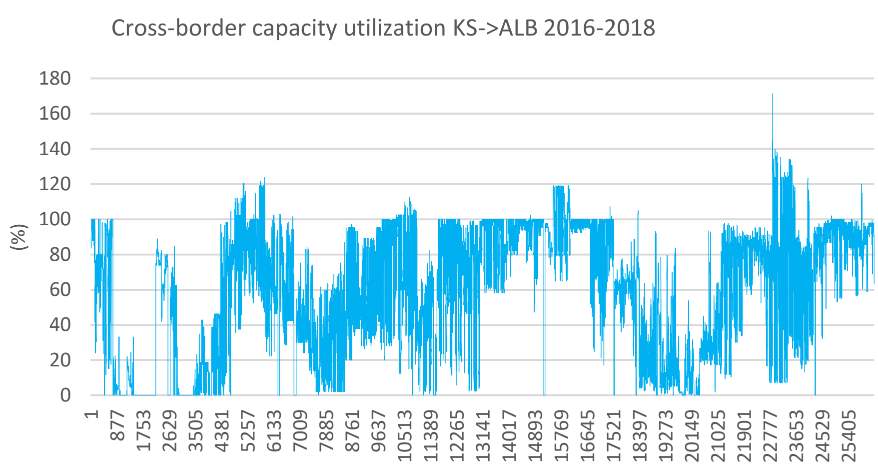


Figure 43 Difference between NTC and scheduled cross-border power flows in direction from Kosovo to Albania in the period 2016-2018



Average cross-border capacity utilization in direction from Kosovo to Albania was 52%.

Figure 44 Utilization of cross-border capacity in direction from Kosovo to Albania in the period 2016-2018



It is important to keep in mind that most of other regional borders are having the same experience (values) with remaining cross-border capacity that is available after scheduled cross-border exchanges are realized. Moreover, it is expected that additional cross-border capacity will be released with D-2 and intra-day capacity calculations. It is highly recommended to investigate is there real physical grid congestions in periods when whole NTC was allocated, with a goal to identify is there a space to give additional capacity to market. Also, this statistical analysis will be important for the above-mentioned historical records needed for estimation of LFC block imbalance values as defined in SOGL.

Level of utilization of Kosovo-Albania cross-border capacities in the period 2016-2018 was 57% in direction from Kosovo to Albania and 25 % in direction from Albania to Kosovo. Clearly, there is a large amount of remaining cross-border transmission capacity that is available in both directions after scheduled flows are realized. This remaining capacity can be used for reserve sharing/exchange between Kosovo and Albania.

Also, it is strongly recommended to establish procedures of D-2 and ID capacity calculations, at least at the borders where cross-border reserve sharing is to be implemented, Kosovo – Albania border. With this approach NTC value can be increased based on TSO/TSO calculation and part of this capacity can be used for reserve sharing/exchange.

Until 3rd EU energy package is fully implemented in SEE region, NTC calculation is full responsibility of the TSOs on the bilateral level. Cross-border capacity allocation for reserve sharing is to be agreed bilaterally by KOSTT and OST and approved by ERO and ERE.

It is still not clear what will be the result of on-going Energy Community initiatives since it merges EU and non-EU members. It must be ensured that coordinated capacity calculation and allocation do not reduce possibility for cross-border reserve sharing.

After full implementation of 3rd EU energy package in SEE, cross-border capacity allocation will result from GLEB implementation. Under these rules benefits of reserve sharing will be easy to calculate.

5. SCOPE OF FORESEEN NEEDS AND POTENTIAL SERVICES (PRODUCTS) TO BE SHARED BETWEEN KOSOVO AND ALBANIA

Reserve capacity dimensioning process for is one of the most important processes in the TSO operational practice. Basic goal is to ensure sufficient reserve capacity to reach predefined standards with a goal to maintain frequency and/or exchange power (e.g. largest outage). But, on the other hand, its costs must be carefully taken into account because reserve capacity costs have significant share in TSO's total operational costs. This process assumes a lot of input data for each power system related to historical and future operation. Main three goals of reserve dimensioning process are:

1. to determine total reserve capacity,
2. to split it between various types of reserve,
3. to define each product specifics (e.g. full activation time (FAT), maximum/minimum duration, time between two activation, etc.).

In practical terms reserve dimensioning process can be done with two different approaches:

- **Probabilistic approach** - based on balancing energy needs observed in historical data, with the goal to determine level of reserve necessary to cover predefined percentage of time (for example 99%)
  AND/OR
- **Deterministic approach** - based on dimensioning incident, i.e. the largest generator/load outage in the LFC block.

New guidelines are heading more to the probabilistic approach. According to the SOGL (Article 157) the FRR dimensioning rules shall include at least the following:

- all TSOs of a LFC block determine the required reserve capacity of FRR of the LFC block based on consecutive historical records comprising at least the historical LFC block imbalance values. The sampling of those historical records shall cover at least the time to restore frequency. The time period considered for those records shall be representative and include **at least one full year period ending not earlier than 6 months before the calculation date**

- all TSOs of a LFC block shall ensure that the positive (same for negative) reserve capacity on FRR or a combination of reserve capacity on FRR and RR is sufficient to cover the positive (same for negative) LFC block imbalances for **at least 99 % of the time**, based on the historical records referred above.

For the reserve sharing agreement:

- the reduction of the positive reserve capacity on FRR of a LFC block shall be limited to the difference, if positive, between the size of the positive dimensioning incident and the reserve capacity on FRR required to cover the positive LFC block imbalances during 99 % of the time, based on the historical records referred above.

- the reduction of the positive reserve capacity using reserve sharing shall not exceed 30 % of the size of the positive dimensioning incident.

Frequency and active power flows must begin to return to their set point values as a result of secondary control after 30 seconds with the process of correction being completed after 15 minutes with a reasonable ramp rate and without overshoot. Even though secondary reserve range values could be defined by equation where the main input is maximum system load, the TSO may determine different values of secondary control reserve for different daily or hourly periods depending on operational power system conditions.

5.1. Reserve capacity needs in Kosovo and Albania

Referring to the existing deterministic legal framework and the ENTSO-E proposal for 2019 and OST input data, OST contribution in FCR is set to +/-5 MW, while aFRR is set to +/-45 MW (as for small Control Area with 1500 MW of the leak load). Largest units in Albanian electricity generation portfolio are in HPP Komani (4x150 MW). It assumes that needed FRR (aFRR+mFRR) capacity is 150 MW.

Similarly, in Kosovo FCR is set to +/-3 MW, while aFRR is set to +/-35 MW (as for small Control Area with 1100 MW of the leak load). Largest units in Kosovo electricity generation portfolio is in TPP Kosovo B (275 MW). It assumes that needed FRR (aFRR+mFRR) capacity is 275 MW[10].

Summarizing operational needs in Albania and Kosovo the following reserve capacities are considered with individual country dimensioning:

	Albania	***Kosovo***
dimensioning upward incident	*150 MW*	*275 MW*
dimensioning downward incident	*-100 MW*	*-50 MW*
FCR	*±5 MW*	*±3 MW*
aFRR	*±45 MW*	*±35 MW*
mFRR(+)	*+105 MW*	*+240 MW*
mFRR(-)	*-100 MW*	*-50 MW*

[10] In some countries this mFRR- value is further reduced with aFRR- value, as it is done here for mFRR+. However, mFRR- here is left as by definition.

Clearly, ACE values in 2018 (in Albania +225 MW/-555 MW, Kosovo +356 MW/-345 MW) in both countries are higher than available/needed reserve capacity and individual dimensioning incidents.

As elaborated in the previous Chapters there are five different ways for FRR reserve dimensioning in Kosovo and Albania depending on the country status in LFC blocks, as given in the following Table.

Table 8. Reserve capacities options for Kosovo and Albania depending on their status in LFC block

Reserve capacity options depending on Kosovo and Albania status in LFC blocks	
Individual LFC blocks	**Common LFC block**
Option 1. Individual dimensioning	**Option 3. Common dimensioning**
Option 2. Individual dimensioning with reserve s	**Option 4. Common dimensioning with reserve sharing**
	Option 5. Common dimensioning with reserve exchange

The first two are under assumption that Kosovo and Albania are in separate LFC blocks, while remaining three options are based on the assumption that Kosovo and Albania are in the same LFC block, as given in the following table ad figure.

The main principles of these reserve capacity options are given on Figure 45.

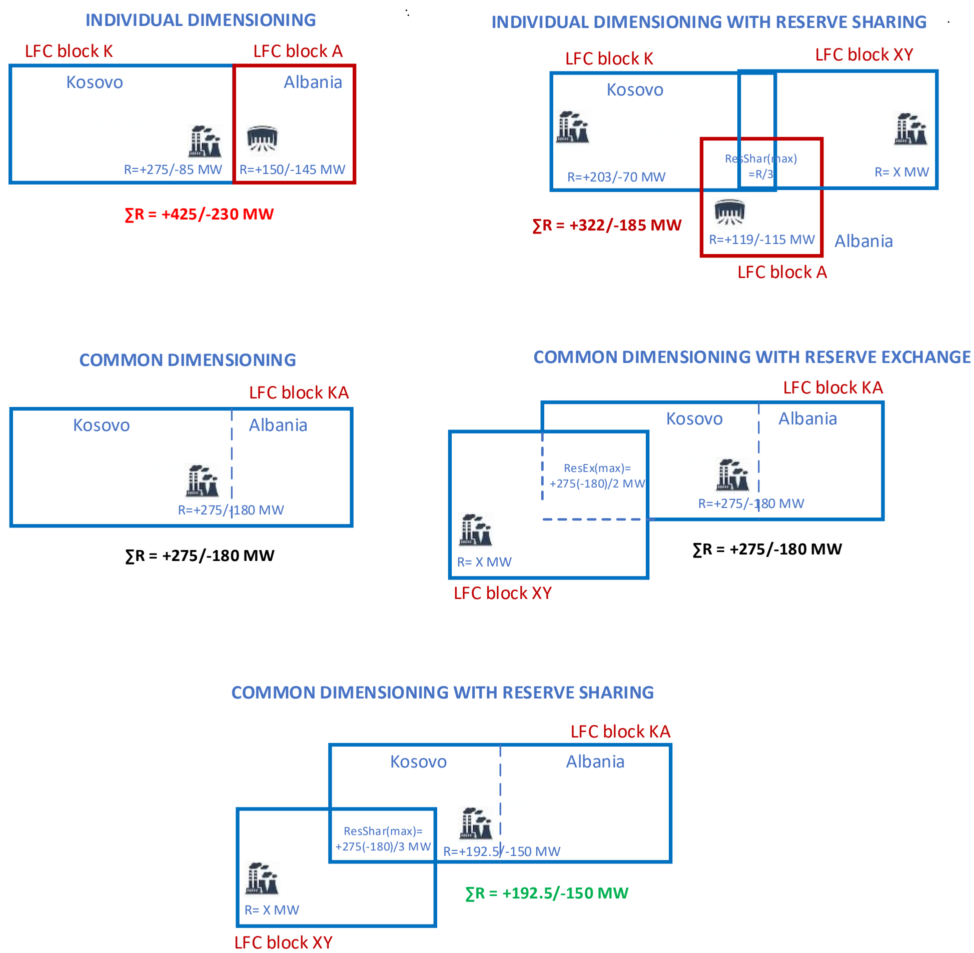
Table 9. Reserve capacities in Kosovo and Albania in analysed options

Reserve capacity (MW)	Albania	Kosovo	Albanija + Kosovo
Individual dimensioning (referent scenario)			
aFRR	45	35	**80**
	-45	-35	**-80**
mFRR	105	240	**345**
	-100	-50	**-150**
FRR+	150	275	**425**
FRR-	-145	-85	**-230**
Individual dimensioning with reserve sharing			
aFRR	45	35	**80**
	-45	-35	**-80**
mFRR	74	168	**242**
	-70	-35	**-105**
FRR+	119	203	**322**
FRR-	-115	-70	**-185**
Common dimensioning			
aFRR	45	35	**80**
	-45	-35	**-80**
mFRR	52	143	**195**
	-67	-33	**-100**
FRR+	97	178	**275**
FRR-	-112	-68	**-180**
Common dimensioning with reserve sharing			
aFRR	45	35	**80**
	-45	-35	**-80**
mFRR	23	89.5	**112.5**
	-47	-23	**-70**
FRR+	68	124.5	**192.5**
FRR-	-92	-58	**-150**
Common dimensioning with reserve exchange			
aFRR	45	35	**80**
	-45	-35	**-80**
mFRR	52	143.0	**195**
	-67	-33	**-100**
FRR+	97	178.0	**275**
FRR-	-112	-68	**-180**

Individual dimensioning would result with total FRR capacity in Kosovo and Albania of +425 MW / -230 MW. Individual dimensioning with reserve sharing would result with total FRR capacity in Kosovo and Albania of +322 MW / -185 MW, saving capacity of +103/-45 MW.

Common dimensioning (assuming Kosovo and Albania are in the same LFC block) would decrease it to +275 MW / -180 MW, decreasing it for +150 MW / - 50 MW which would be released for market activities. Reserve exchange of Kosovo-Albania LFC block with other LCF blocks would not result with any decrease in total FRR/RR capacity need. It would just be re-allocated in the other LCF block. The largest decrease in FRR/RR capacity is found with reserve sharing with other LFC block where total FRR/RR capacity is additionally decreased to +192.5 MW / -150 MW, which is 232.5 MW / -80 MW less than with starting positions with individual dimensioning.

Figure 45 Five different ways for reserve capacity dimensioning in Kosovo and Albania



TSOs in the same LFC block are free to agree on the common dimensioning and reserve sharing principles. However, the previous Table showed reserve capacities that should be paid by both sides in each option. It doesn't represent necessarily geographical location of reserve capacity. Common dimensioning and reserve sharing are based on the contribution of Kosovo and Albania that is proportional to the initial reserve capacity in the case of individual dimensioning (275 ÷ 150). Also, it is assumed that aFRRs remain the same in all options, while common dimensioning and reserve sharing are done with mFRR only. TSOs can agree differently and share aFRR as well, especially if aFRR capacity price is higher than mFRR capacity price. However, input data received from OST show quite low aFRR capacity price (2.18 €/MW), which is lower than the price of mFRR in the region 3-6 €/MW. Therefore, for this study case with these input data the authors assumed the following reserve capacities in given options.

For these principles commercial and legal issues need to be resolved for contracts to be drawn up. Currently, OST has a contract with KOSTT to deliver 25 MW of aFRR (although not agreed upon price), but the contract cannot commence until Kosovo is recognized as ENTSO-e LFC area. Since all technical conditions are fulfilled, this remains only a political issue.

5.2. Cost-benefit assessment

It is important to note that cost-benefit assessment in this study is based on limited input dataset. Input dataset is limited mainly due to non-existing balancing market and/or system balancing practice in Kosovo and Albania. Therefore, these analyses and numerical results can be treated as the first phase that should be easily updated with longer ancillary services and balancing mechanism practice in Kosovo and Albania. Detailed analyses and follow-up study need to be done later with full datasets available, related to, but not limited to:

1. quantities of requested and activated reserve capacities (aFRR, mFRR/RR)
2. related service providers' offers with quantities and prices
3. transparent process of reserve price determination

This cost-benefit assessment is based on the assumption that both countries already have individual dimensioning fully in place, with capacity costs and full response of the power plants on the TSOs' activation calls. That is currently not the case. Currently, in Kosovo there is no contract for reserve capacities, while in Albania service provider's response on reserve capacity requests is not fully in place. To be more precise, KOSTT and OST have contract in place for aFRR reserve exchange, but it is not implemented due to non-implementation of the Connection Agreement KOSTT-ENTSO-e.

For this analysis, the following assumptions are taken:

1) Assumptions:

1. dimensioning incidents are:
   a. Kosovo: 275 MW (TPP Kosovo B unit) and -50 MW (Feronikal)
   b. Albania: 150 MW (HPP Komani) and -100 MW (Kurum Steel)

2. It is assumed that sum of aFRR+mFRR is equal to dimensioning incident. RR is not contracted separately, as it is the case in most of the regional countries (see Chapter 3.1.4).

3. aFRR is calculated with the ENTSO-e formula resulting with:
   a. aFRR(KS)=±35 MW
   b. aFRR(AL)=±45 MW

4. Kosovo: mFRR=FRR-aFRR=275-35=+240 MW Albania: mFRR=FRR-aFRR=150-45=+105 MW mFRR is not symmetrical (upward and downward), as it is the case in most of European countries [12].

5. due to high ACE and lower price than for mFRR, aFRR capacity is kept the same in both systems, and it is not common dimensioned.

6. reserve capacity price is the same for upward and downward

7. reserve sharing: proportional 30% decrease is calculated both for mFRR upward and downward

8. aFRR price is taken from existing OST contract: aFRR price is 2.18 €/MW. mFRR is taken from the regional average of 4.25 €/MW. These values are quite low compared to the other regional countries. Moreover, aFRR is usually much more expensive than mFRR. For comparison, aFRR capacity price in Croatia is 13.3 €/MW, in Austria 14 €/MW, in Slovenia 21 €/MW, in Serbia 9.11 €/MW, in Montenegro 9.2 €/MW, while mFRR capacity price in Croatia is 6.60 €/MW, in Austria 4-8 €/MW (different prices for upward and downward capacity), in Slovenia 4.25 €/MW, in Serbia 2.9 €/MW, in Montenegro 1.8 €/MW[11].

9. There is available reserve capacity in the neighboring countries.

10. Reserve capacity cost in the neighboring systems is the same as in LFC block Kosovo-Albania.

2) Power plants available for the system reserve needs

EU Regulation 2016/631 on establishing a network code on requirements for grid connection of generators, among other things, classifies units connected to the system and sets clear definitions of

[11] There are different approaches in balancing mechanism costs in the region: cheap capacity, expensive energy, or vice-versa.

technical capabilities to offer ancillary services. Transposition of this regulation is required. Compliance will be compulsory for those generators that are capable.

Power plants available for system reserve needs in Kosovo and Albania are given in the following table. HPP Ujmani in Kosovo has limitations in operation and control, so it is not used for ancillary services.

Table 10. Power plants in Kosovo and Albania available for regulation and its characteristics

GENERATION UNIT	UNIT CAPACITY (MW)			
KOSOVO				
TPP Kosovo A	Installed	Net	Available min	Available max
A1	65	0	0	0
A2	125	0	0	0
A3	200	182	120	144
A4	200	182	120	144
A5	210	187	120	144
TPP Kosovo B				
B1	339	300	180	275
B2	339	300	180	275
ALBANIA				
HPP Fierza (4 units)	125	125	90	125
HPP Komani (4 units)	150	145	90	145
HPP Vau Dejes (5 units)	50	50	28	50
HPP Banja (2 units)	32.3	32.3	20	32
HPP Fang (2 units)	36	34	11	34
HPP Moglica* (2 units)	85.6	85	30	85

However, since in Kosovo all units are coal fired, ramp rates are very low (1 MW/min, except B1 with 5 MW/min[12]) which is usually not adequate for (fast) system reserve needs. On the other side, HPPs in Albania are fully dependent on hydrology, with very limited reserve capacities available during dry seasons. Therefore, it is clear benefit to both sides to combine and share system reserve capacities in order to minimize total reserve capacity needs and respective costs.

5.2.1. What are reserve capacity reduction options and its costs?

Reserve capacity payment mechanisms in Kosovo and Albania are currently on the very early stage. It is expected soon that both countries will fully comply with ENTSO-e requirements and network codes and guidelines and ensure enough reserve for their systems. This might assume much higher reserve capacity and balancing energy costs than today. Taking into account all assumptions and inputs mentioned above, the following tables show annual costs for Kosovo and Albania for aFRR and mFRR.

[12] These values are taken from the TPP Kosovo C Generation Unit Sizing study, USAID, 2016

Table 11. aFRR capacity costs and savings in Kosovo and Albania in analysed options

aFRR	Costs mil.€/Year*		Savings compared to individual dimensioning mil.€/Year	
	Kosovo	Albania	Kosovo	Albania
Individual dimensioning	1.3	1.7		
Common dimensioning	1.3	1.7	0.0	0.0
Reserve exchange	1.3	1.7	0.0	0.0
Reserve sharing	1.3	1.7	0.0	0.0

With the current level of aFRR price (2.18 €/MW) expected annual aFRR capacity cost in Albania is 1.7 mil.€ and in Kosovo 1.3 mil.€. So, total aFRR costs for Kosovo and Albania would be 3 mil.€/year.

Clearly, due to its low aFRR capacity price, it is not justified to use reserve sharing mechanisms to decrease aFRR capacity and its costs. Instead, common dimensioning and reserve sharing is applied to mFRR only, which is currently more expensive. The results are given in the following table.

Table 12. mFRR capacity costs and savings in Kosovo and Albania in analysed options

mFRR	Costs mil.€/Year*		Savings compared to individual dimensioning mil.€/Year			
	Kosovo	Albania	Kosovo	Albania	TOTAL	%
Individual dimensioning	10.8	7.6				
Individual dimensioning with reserve sharing	7.6	5.4	3.2	2.3	5.5	29.9
Common dimensioning	6.6	4.4	4.2	3.2	7.4	40.5
Reserve exchange	6.6	4.4	4.2	3.2	7.4	40.5
Common dimensioning with reserve sharing	4.2	2.6	6.6	5.0	11.6	63.2

Total mFRR costs in both countries with individual dimensioning (no matter where reserve capacities are located) is 18.4 mil.€/year. If reserve sharing is applied to individual dimensioning then the total costs would be decreased for 5.5 mil.€/year, or 30%.

In the case of LFC block Kosovo – Albania is formed, common dimensioning can be applied with the costs decreased for 7.4 mil.€/year or 40.5%. Reserve exchange with neighboring LCF block would also be possible, but without any direct financial savings (assuming the same mFRR capacity price in the other block). Eventual benefits of reserve exchange would be to release some of the local reserve capacity for market activities.

However, common dimensioning combined with reserve sharing would assume potential saving of 11.6 mil.€/year or 63% compared to individual dimensioning.

Accordingly, it is recommended to target common dimensioning combined with reserve sharing principle as the best reserve capacity option for both systems.

5.2.2. What is the income from cross-border capacity allocation?

One of the key questions for this study is how much of cross-border capacity needs to be allocated for common reserve dimensioning and/or reserve sharing. In other words, what about income from cross-border transmission capacity allocation in that case?

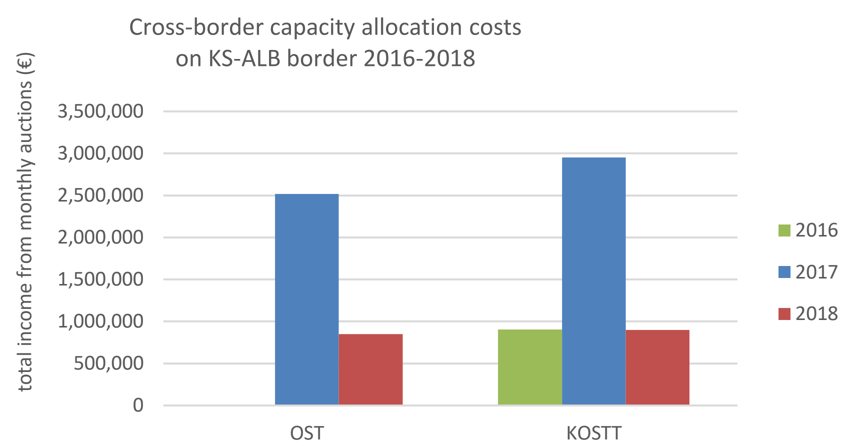
Before answering to that question, it is important to know: what was the total income from cross-border capacity allocation in previous years on Kosovo – Albania border? Data available for monthly auctions of cross-border transmission capacities are given in the following Table.

Table 13. Cross-border capacity allocation income of KOSTT and OST in 2016-2018

Cross-border capacity - monthly auctions income (€)	Albania →Kosovo	Kosovo→ Albania	Total
	2016		
OST			
KOSTT	182,254	714,710	896,964
	2017		
OST	170,000	2,347,000	2,517,000
KOSTT	303,013	2,647,919	2,950,932
KOSTT+OST	473,013	4,994,919	5,467,932
	2018		
OST	450,000	400,000	850,000
KOSTT	622,215	276,757	898,972
KOSTT+OST	1,072,215	676,757	1,748,972

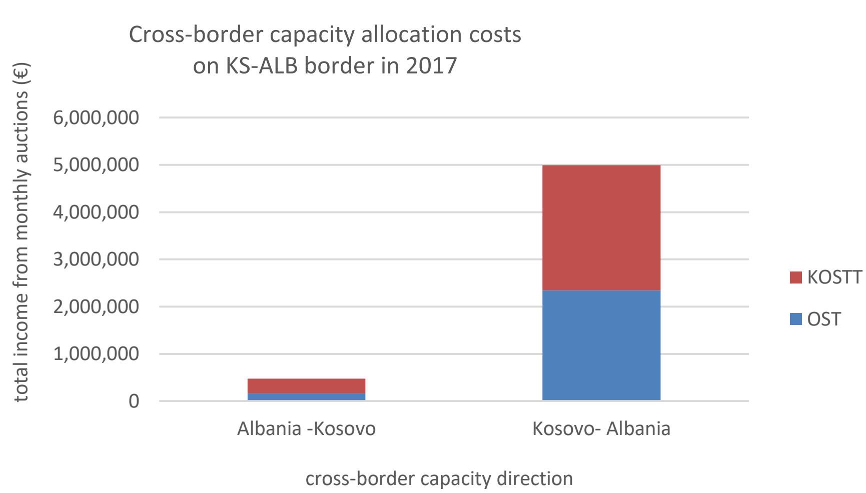
For 2016 data are available for KOSTT only, with total income of around 0.9 mil.€ (in the case of equal sharing of cross-border capacity allocation income, it would assume that OST also received around 0.9 mil.€. Total income in 2016 would then be 1.8 mil.€). In 2017 total income was at the level of 5.5 mil.€, while in 2018 it was just 1.75 mil.€. It is graphically presented on the next two figures.

Figure 46. Cross-border capacity allocation income on KS-ALB border 2016-2018



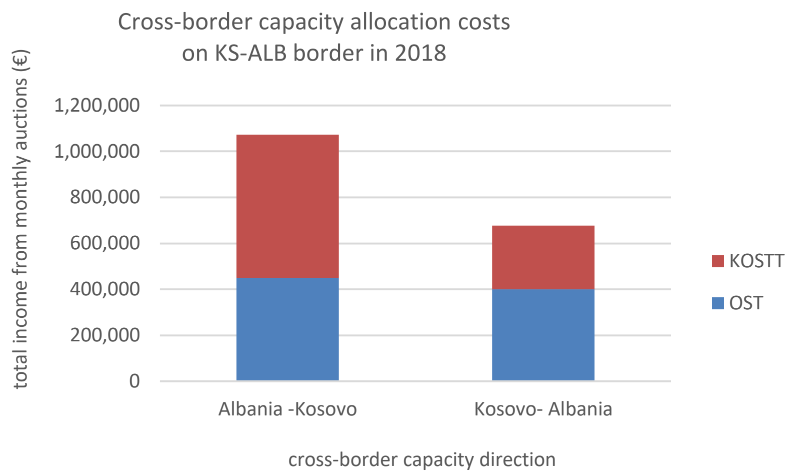
In 2017 almost all cross-border capacity allocation income is related to Kosovo→Albania direction, as given on the following Figure.

Figure 47. Cross-border capacity allocation costs on KS-ALB border in 2017 depending on direction



In 2018 62% of the cross-border capacity allocation income was made on the direction Albania→Kosovo and 38% is for direction Kosovo→Albania.

Figure 48. Cross-border capacity allocation costs on KS-ALB border in 2018 depending on direction



Total cross-border capacity allocation income in the period 2016 – 2018 on Kosovo – Albania border was in the range 1.75 – 5.5 mil.€/year. On the other side, savings with common mFRR reserve dimensioning and reserve sharing would be in the range 4.5-8.7 mil.€/year, which is much higher than total cross-border capacity allocation income for both TSOs. In that case it is easy to justify usage of cross-border capacity for common reserve dimensioning and sharing. Cross-border capacity allocation for reserve exchange could limit market activities in given directions. However, as given above, part of cross-border capacity remains available even after scheduled market transactions. Total impact of cross-border capacity allocation for reserve exchange/sharing on electricity market prices is calculated using market simulator and given below.

5.2.3. How much cross-border transmission capacity would be needed for reserve sharing?

Cross-border transmission capacity needed for reserve sharing between Kosovo and Albania depends on the reserve sharing option. Every LFC block needs to have 50% of its reserve capacity located internally, within the block. If Kosovo and Albania are individual LFC blocks (individual dimensioning), then 50% of their reserve capacity could be imported, meaning that the same cross-border capacity needs to be allocated.

When in the common LFC block, the TSOs can agree on the geographical distribution of the reserve capacity location. In other words, if Kosovo and Albania are in the same LFC block, the whole commonly dimensioned reserve capacity could be located in Albania (or in Kosovo). Also, any other capacity location share can be agreed among the TSOs, depending on availability and financial effects.

Cross-border capacity range needed for each reserve sharing option is given in the following table.

Table 14. Cross-border transmission capacity needed for analysed cases

Cross-border capacity needed for reserve sharing (MW)	Kosovo→ Albania	Albania→ Kosovo
Individual dimensioning		
(50% of reserve capacity can be imported. Eventual aFRR capacity import can also be added to these values)	75	137.5
Common dimensioning		
(TSOs can agree on any geographical distribution of reserve capacites within the LFC block)	0-150	0-275
Reserve exchange		
(TSOs can greely agree on geographical distribution of reserve capacites within the LFC block)	0-150	0-275
Reserve sharing		
(TSOs can greely agree on geographical distribution of reserve capacites within the LFC block. 50% of reserve cpacity has to be located within the LFC block)	0-100	0-192.5

The same values are grouped in 50-MW lots and presented in histogram format on the following two figures. 69% of the time (18076 out of 26308 hours) remaining cross-border capacity from Albania to Kosovo is larger than 200 MW. This cross-border capacity can be used for reserve capacity exchange/sharing. In other words, theoretically, in more than 2/3 of the time (69%) Kosovo system can import reserve capacity larger than 200 MW from Albania without jeopardizing cross-border market activities.

55% of the time (14409 out of 26308 hours) remaining cross-border capacity from Kosovo to Albania is larger than 100 MW. This cross-border capacity can be used for reserve capacity exchange/sharing. In other words, theoretically, in more than 1/2 of the time (55%) Albania system can import reserve capacity larger than 100 MW from Kosovo without jeopardizing cross-border market activities. Moreover, 33% of the time (8734 out of 26308 hours) remaining cross-border capacity from Kosovo to Albania is larger than 200 MW.

If cross-border capacity is needed for reserve capacity exchange/sharing, currently in practice there are four options for cross-border capacity allocation:

1.Cross-border capacity is not ensured in advance (this is feasible with the current level of Kosovo-Albania cross-border capacity utilization (see Chapter 4.3.2) and expected additional cross-border capacity with new 400 kV line in operation),

2.Cross-border capacity is ensured by balancing service provider (BSP),

3.Cross-border capacity is allocated by the TSO for system balancing needs,

4.Kosovo and Albania operate as one single market without bilateral NTCs. In this case there are no restrictions on balancing energy exchange and geographical distribution of reserve capacities. However, in that case there will be no revenues from cross-border capacity allocation.

TSOs and NRAs should decide on the most appropriate option and sign an agreement with operational details.

In the option 3, TSOs should firstly agree on the geographical location of reserve capacities in both countries and then on Kosovo-Albania cross-border transmission capacity to be allocated for the reserve capacity sharing. Currently available capacity is up to 250 MW in both directions, so part of this capacity should be saved for reserve exchange, while remaining cross-border capacity would be released for other market activities.

5.2.4. Electricity market simulation results

Electricity market analysis is performed using PLEXOS market simulation software and detailed market model of the whole South East Europe verified by all regional TSOs, including Croatia, BiH, Serbia, Montenegro, Kosovo, Albania, Macedonia, Romania, Bulgaria and Greece. Electricity market is simulated for 2020 on hourly time-frame for the whole year.

Three scenarios are compared:

1) **Individual dimensioning** of reserve capacity
2) **Common dimensioning** of reserve capacity within Kosovo-Albania LFC block
3) Common reserve capacity dimensioning and **reserve sharing** with neighboring LFC block

The simulation resulted with large set of output values. For the purpose of this study outputs relevant for this topic are selected as follows for all three scenarios in five different aspects:

1) Annual FRR reserve capacity costs (mil.€/year)
2) Number of hours with reserve capacity shortage (h/year) – this is the time when available reserve capacity is not enough to cover system needs and it needs to be procured abroad
3) Annual reserve shortage – sum of hourly reserve capacities not available for balancing needs (MWh) – this is missing capacity multiplied with item 2)
4) Savings in annual total electricity costs – the difference in total wholesale electricity market price multiplied by total electricity demand (mil.€)
5) Number of hours with congestion on Kosovo-Albania border (h) – this is the time when Kosovo-Albania border is congested. With cross-border reserve capacity exchange it is expected that this number will grow, so the savings will be negative.

The results are given in the following table.

Table 15. Market simulation results – absolute annual values

	Annual FRR reserve capacity costs (mil.€/year)	Number of hours with reserve capacity shortage (h/year)	Annual reserve shortage (MWh)	Total annual electricity costs (mil.€)	Number of hours with congestion on KS-ALB border (h)
Individual dimensioning	18.4	897	50,759	668.21	7,424
Common dimensioning	11.0	119	1,015	654.33	7,571
Reserve sharing	8.8	58	910	653.83	7,523

Table 16. Market simulation results – savings in reserve capacity costs, reserve shortage, electricity costs and congestion hours

	Savings in annual FRR reserve capacity costs (mil.€/year)	Savings in number of hours with reserve capacity shortage (h/year)	Savings in annual reserve shortage (MWh)	Savings in total annual electricity costs (mil.€)	Savings in number of hours with congestion on KS-ALB border (h)
Individual dimensioning	-	-	-	-	-
Common dimensioning	7.4	778	49,744	13.88	-147
Reserve sharing	9.6	839	49,849	14.38	-99

Besides savings in annual FRR reserve capacity costs, there are large savings in total annual electricity costs. With common dimensioning and reserve sharing some generation capacity is released for the market. It impacts electricity prices in both countries resulting with total annual saving in electricity costs of about 14 mil.€. In addition to that, there is a saving in reserve shortage. It is represented here as missing reserve capacity multiplied by number of hours with reserve capacity shortage. It is around 50 GWh. As expected, number of hours with congestion on Kosovo-Albania border is slightly increased.

As noted above, the reserve sharing contract between KOSTT and OST has been signed few years ago, but it's not implemented yet. If reserve sharing/exchange options between KOSTT-OST couldn't be realized due to non-implementation of KOSTT-ENTSO-e Connection Agreement, then these results can be taken as direct financial consequence.

5.3. Exchange of single and multiple standardized products

Among other, GLEB lists the minimum set of standard characteristics and additional characteristics defining standard products. In Article 25 GLEB specifies that by two years after entry GLEB into force, all TSOs shall develop a proposal for a list of standard products for balancing capacity for FRR and RR. At least every two years, all TSOs shall also review the list of standard products for balancing energy and balancing capacity.

As defined in GLEB, the list of **standard products** for balancing energy and balancing capacity may set out at least the following characteristics of a standard product bid:

- preparation period;
- ramping period;
- full activation time;
- minimum and maximum quantity;
- deactivation period;
- minimum and maximum duration of delivery period;
- validity period;
- mode of activation.

The list of standard products for balancing energy and balancing capacity needs to set out at least the following variable characteristics of a standard product to be determined by the balancing service providers during the prequalification or when submitting the standard product bid:

- price of the bid;
- divisibility;
- location;
- minimum duration between the end of deactivation period and the following activation.

Standard products for balancing energy and balancing capacity will:

- ensure an efficient standardization, foster cross-border competition and liquidity, and avoid undue market fragmentation;

- facilitate the participation of demand facility owners, third parties and owners of power generating facilities from renewable energy sources as well as owners of energy storage units as balancing service providers.

Above mentioned characteristics of standard products for balancing services are under discussion within relevant ENTSO-e bodies. The main open issue is related to Full Activation Time (FAT) parameter for aFRR and mFRR. Final goal is to define standard products suitable for exchange via common platform for aFRR (PICASSO) and mFRR (MARI) as described in the Chapter 3. So, when platforms will be operational, every TSO which intends to participate should implement standard products in their balancing market. Before that TSOs should define suitable product, which fits to their needs. For KOSTT and OST detailed analysis is given in the next chapter.

The term "standardized products" is linked to MARI and PICASSO platforms. Since KOSTT and OST need products to balance the system immediately, before the decision on standardized products, some recommendations are given in the following subchapter.

5.4. Exchange of non-standardized products

Following the approval of the implementation frameworks for the European platforms, each TSO may also develop a proposal for defining and using specific additional **non-standardized products** for balancing energy and balancing capacity. This proposal shall include at least:

- a definition of specific products and of the time period in which they will be used;
- a demonstration that standard products are not sufficient to ensure operational security and to maintain the system balance efficiently or a demonstration that some balancing resources cannot participate in the balancing market through standard products;
- a description of measures proposed to minimize the use of specific products subject to economic efficiency;
- where applicable, the rules for converting the balancing energy bids from specific products into balancing energy bids from standard products;
- where applicable, the information on the process for the conversion of balancing energy bids from specific products into balancing energy bids from standard products and the information on which common merit order list the conversion will take place;
- a demonstration that the specific products do not create significant inefficiencies and distortions in the balancing market within and outside the scheduling area.

Each TSO using specific products will review at least once every two years the necessity to use specific products in accordance with the criteria given above. The specific products will be implemented in parallel to the implementation of the standard products.

Until than if there is need for common approach it is up to TSO or TSOs to define products related to activation of balancing reserves. Regularly, technical characteristics (e.g. ramp rate, reservoir volume, etc.) of local Balancing Service Providers should be taken into account. It is always a tradeoff between regulation quality and market liquidity. It is better to have very quick response, but on the other hand, there is limited number of units capable to react fast.

With a reference to proposed mFRR exchange and technical capabilities from Chapter 5.2. any reduction of FAT would significantly reduce capability of units in KOSTT control area to participate in reserve market. Therefore, it is recommended to keep FAT on a 15 minutes with a unspecified ramping period. This mean that from base power to activated power BSP could go with step function or quick ramp (in case of HPP) or slowly with slow ramp (in case of slow TPP). Nevertheless, it is recommended that quick reaction is welcomed and paid by the TSOs and it is recommended to be part of ancillary services contract.

On the other hand, definition of minimum and maximum duration of delivery period is strictly related to overall balancing mechanism on a level of bidding zone. In developed balancing market reserves are activated for short period taking into account that every BRP intends to balance itself as soon as it possible, trying to avoid to be imbalanced because this brought financial penalties. It is obvious from ACE values of Kosovo and Albania, this is not a case in these two countries. Additionally, when determining maximum duration of balancing energy delivery, it should be taken into account that energy reservoirs are not infinite. Taking into account above mentioned, it is recommended to set the minimum duration to 1 hour and maximum up to 4 hours. The goal is to quickly cover system imbalance and release activated reserve capacity as soon as possible by: BRP procurement of missing energy or TSO procurement of balancing energy on wholesale market (Assumption is that balancing energy from activated reserve is more expensive than energy obtained on a regular market). Additionally, it is strongly recommended to check the feasibility of proposed characteristics during prequalification process, before signing of ancillary service contracts.

Regarding minimum duration between the end of deactivation period and the following activation for hydro power plants in most of the cases there are not technical restrictions, but in case of thermal units there could be a problem and this duration could last for hours. It is strongly recommended to determine this parameter during prequalification process, before signing of ancillary service contracts.

Other parameters should be determined and based on balancing market characteristics. This should be defined in national balancing codes and are related to the competition on the balancing market. In KOSTT and OST case, when there are just two significant BSPs, so price regulation is needed if there's no real market. All of the above-mentioned product characteristics should be part of LFC block agreement.

To conclude, taking into account technical capabilities of service providers' units it is recommended to define single standardized product for mFRR with FAT equal to 15 minutes. Key driver is to include in this mechanism as much BSPs as possible, as well as create the product which could be procured from other LFC blocks, besides KOSTT and OST.

6. PROPOSAL FOR EVENTUAL LEGAL FRAMEWORK UPDATES TO SUPPORT CROSS-BORDER EXCHANGE OF THESE SERVICES BETWEEN KOSOVO AND ALBANIA

Before going into legal framework to support cross-border exchange of power system reserves it is important to note that lot of activities have been taken so far in the last few years to integrate Kosovan and Albanian electricity market and to form Albanian power exchange (APEX). Memorandums of understandings have been signed, common working groups established, and lot of concrete steps taken to organize and implement it. In short, it is expected that APEX will be formally established in 2019 by OST, located in Albania, while KOSTT (and eventually other shareholders) should be a founding member of the APEX. APEX will be another "tool" for all electricity market participants in the region. Every participant in the market should demonstrate its credit-worthiness, having bilateral contracts with APEX. Everyone who wants to trade in the market will be a Balance Responsible Party. APEX will function with two bidding zones with the NTC values in between: Albania and Kosovo. APEX will open the branch in Kosovo, with the registration of the branch in Kosovo the tax issues will be solved. When APEX will go live, the electricity will flow from low price area to high price area and optimize operation of hydro and thermal generation portfolio in both countries. Currently, it is discussed what would be the mandatory volume for Kosovo and Albania to participate in APEX. According to Albanian electricity market design in the first three years of APEX operation the obligatory volume to be traded through APEX is set to 50% (1st year), 75% (2nd year) and 90% (3rd year) of total amount of electricity generated/supplied in Albania. It will significantly support APEX liquidity. On Kosovo side mandatory volume is still under discussion. A particular discussion is on the Bulk Supply Agreement between KEK and KESCO and how to overcome that constraint and enable KEK to offer certain part of its production to APEX.

In any case, it is expected to have more dynamic cross-border flows between two countries in the future. It will certainly affect cross-border exchange of power system reserves between these two countries. Additionally, power exchange will be used by several TSOs to buy/sell balancing energy, especially for the balancing responsible groups which have no financial balancing responsibility (if any).

6.1. Current status of the legal framework in Albania

Albania transposed the provisions of the 3rd EU package into national legislation [10]. However, as given in [10], for its implementation a set of secondary legislation need to be completed. Recent activities regrading balancing mechanism, balancing exchange and reserve sharing have been focused on the following three documents/projects:

1. Transitional Balancing Mechanism (2018): with the assistance provided under the Western Balkans 6 initiative, the associated rules were approved by the national regulatory agency (ERE). Balancing Rules in Albania are part of the Grid Code. It entered into force on 1 January 2018[13].

[13] http://ere.gov.al/doc/Transmission_Network_Code_14.06.2018.pdf

2. Provisional Market Rules (2016): with the set of provisions that determine the procedures for market operations and management. It also includes main conditions for participation in the balancing electricity market. Provisional Market Rules have been adopted by ERE in 2016. ERE also adopted a new Market Rules, but it will enter into force after APEX becomes operational[14].

3. Design and Implementation of the Albanian Electricity Balancing Market (2018): with the assistance provided by International Finance Corporation (IFC), which is currently in the development phase.

Albanian Grid Code recognizes the option of reserve sharing. In Article 147 *Agreements for share and/or activation of reserves* it is defined that OST shall conclude an agreement with participating TSOs in cross-border activity for sharing or exchanging of reserves, in accordance with the terms that will define the roles and responsibilities of each participating TSO. The details dealt with cross-border FRR and RR activation process are defined in Articles 159 and 160. For the cross-border FRR activation OST shall have the right to implement the cross-border FRR Activation Process for LFC areas within the same LFC block, between different LFC blocks by concluding a cross-border FRR Activation Agreement. Also, for the cross-border RR activation OST shall have the right to implement the cross-border RR Activation Process for LFC Areas within the same LFC block, between different LFC blocks or between different synchronous areas by concluding a cross-border RR Activation Agreement.

Accordingly, the agreements between TSOs may be concluded if the security of the systems is not threatened. Article 161 defines that OST shall be part of a Synchronous Area Operational Agreement in which are defined the roles and the responsibilities of the TSOs implementing an Imbalance Netting Process, a cross-border FRR Activation Process or a cross-border RR Activation Process between LFC areas of different LFC blocks. All TSOs willing to implement an Imbalance Netting Process, a cross-border FRR activation, a cross-border RR Activation Process, exchange of reserves or sharing of reserves shall send a notification to all TSOs of the Synchronous Area three months in advance. Where an Imbalance Netting Process, a cross-border FRR Activation Process or a cross-border RR Activation Process is implemented for LFC areas which are not parts of the same LFC block, each TSO of the involved Synchronous Areas shall have the right to declare itself to all TSOs of the Synchronous Area as an Affected TSO based on Operational Security Analysis within one month after notification. OST in coordination with neighbouring TSO's shall consider the technical infrastructure necessary to implement and operate one or more processes or frequency restoration.

The action plan regarding balancing is part of the new Market Model and "Design and Implementation of the Albanian Electricity Balancing Market". Regarding the monitoring of balancing mechanism, the role of ERE is foreseen in the Energy Law (43/2015). The Law defines that the regulator's responsibility is to approve the procedures and to monitor procurement of energy for covering the balancing and ancillary services required for operating the system through competitive non-discriminatory and transparent procedures.

[14] http://ere.gov.al/doc/Rregullat_e_Tregut_Shqiptare_te_Energjise_Elektrike_..docx(final).pdf

In addition to the above-mentioned legislation, since 2011 *Regulation on Allocation of Interconnection capacities* is in force in Albania. This Regulation does not include cross-border transmission capacity allocation for the reserve sharing needs. *Rules and Procedures for electricity exchange* are from 2006 and are not relevant for this topic, so the treatment of cross-border transmission capacity for reserve sharing is supposed to be defined within TSOs Agreement on reserve sharing and activation.

According to Chapter VI. of the Grid Code in Albania, cross-border FRR and RR is allowed after signing the TSOs agreement(s) for reserve sharing and/or reserve activation. FCR should be fully ensured within the national system.

So, for cross-border reserve capacity exchange in Albania there is no need for further legal framework updates. There is a need to sign the TSOs Agreement on reserve sharing and activation, including ERE approval, as well as to improve IT and meter-reading systems, to make it operational and adequate for market-based ancillary service mechanism.

6.2. Current status of the legal framework in Kosovo

KOSTT is responsible for the allocation of transmission interconnection capacities in the power system in Kosovo. The allocation of interconnection transmission capacities is done based on the "Operational Procedures for Interconnection Capacity Auction and Cross-Border Capacity Nomination", approved by the ERO. The regulatory framework regarding the balancing mechanism is in place and implementation started on June1 , 2017. Now it is implemented, and potential weaknesses could have been identified in the first year of practice and addressed through improvements of the regulatory framework.

No action plan regarding balancing issues is existing at this moment but is expected to be prepared in the near future. National legislation empowers the ERO to monitor the electricity market, including the balancing mechanism. Namely, Article 16 of Law on the Energy Regulator defines: "The Regulator shall be responsible for monitoring of the operation of the markets for electricity, thermal energy and natural gas, to ensure efficient functioning of those markets, and to identify any remedial action that is required… ". This article includes monitoring of interconnectors, mechanism for congestion, market opening, balancing etc.

Grid Code of Kosovo transmission network has been adopted in October 2018. Balancing code is given in the Chapter V. of the Grid Code and contains frequency control code.

KOSTT will use services that are provided under the balancing mechanism and/or ancillary services agreements to ensure load-frequency control. On the other side, service provider will meet the requirements of the Market Rules and/or ancillary services agreement. Balancing mechanism participants have to fulfil the terms of the Market Rules for the provision of services to the balancing mechanism.

All hydro power plants with an output greater then 20 MW must be capable of delivering FRR and be equipped accordingly. The Grid Code of Kosovo does not recognize cross-border FRR and RR as the options for system restoration.

The Electricity law of Kosovo (No. 05/L-085) was adopted in June 2016. It doesn't mention the cross-border reserve exchange or cross-border balancing. However, the Law recognizes balancing energy and gives the permission to the TSO to take measures and activate offers for sale and purchase of electricity for balancing, based on the list of offers according to the economic criteria.

The procedure for interconnector capacity auction and cross-border capacity nomination in Kosovo sets out the way of allocation of available transfer capacity on the interconnection lines. However, it doesn't mention cross-border balancing or reserve sharing. KOSTT is responsible for the cross-border capacity determination and harmonization with the neighboring TSOs. KOSTT defines cross-border capacity auction periods. The auction bids for the cross-border capacity is valid only through KOSTT Energy Management System (EMS). EMS access right is given only to registered participants.

EMS should be upgraded to ensure possibility for cross-border balancing energy/capacity. Contracting, validation and activation of cross-border reserve capacity and balancing energy should be additionally elaborated in Kosovo legal framework.

The legislation framework in Kosovo does not specifically recognize cross-border FRR and RR capacity, but at the same time it does not forbid it. However, inter-TSO agreement on common reserve dimensioning and sharing needs to be approved by ERO.

Besides provisions on reserve capacity sharing it is necessary to have harmonized Market Rules and Balancing Rules between two countries to make a clear whole procedure for cross-border transmission capacity allocation for reserve exchange/sharing. The most important aspects of the legal framework harmonization assume the following:

1. Provisions within the Market Rules related to dispute resolution need to encompass both ERE and ERO - in case of cross-border reserve sharing issues. ERE and ERO need to internally develop the process concerning how they will provide rulings in such cases, including cross-recognition of rulings of ERE and ERO in the other territory for selected cases with regards to cross-border reserve capacity issues.
2. Harmonized reserve capacity and needed cross-border capacity planning, allocation and activation between the TSOs.
3. Provisions of the metering code should also be harmonized between the TSOs to consistently measure, calculate, exchange and store metered values and information from both sides of the border.

Speaking of inter-TSO agreement, it is recommended to analyze other regions experience. Good examples could be found in the Nordic region where two documents were in public consultation. In the first document, Nordic TSOs proposed methodology for a market-based allocation process of cross-zonal capacity for the exchange of aFRR balancing capacity. Nordic TSOs intend to establish a common aFRR capacity market, and for that reason they developed common harmonized rules and processes for the exchange and procurement of aFRR capacity. Nordic TSOs intend to allocate cross-zonal capacity in order to secure the exchange of aFRR capacity via market-based allocation. This proposal fulfils Article 38(1) and Article 41(1) of GLEB, which require a proposal for the methodology of this allocation process.

In the second document, Nordic TSOs proposed establishment of common and harmonized rules and processes for the procurement and exchange of aFRR balancing capacity. Nordic TSOs intend to allocate cross-zonal capacity in order to secure the exchange of aFRR capacity via market-based allocation. This proposal also fulfils Article 38(1) and Article 41(1) of GLEB, which require a proposal for the methodology of this allocation process. Nordic TSOs intend to allocate cross-zonal capacity in order to secure the exchange of aFRR capacity. Clearly, there are examples of close cooperation of the TSOs in preparation of the common approach to the reserve/balancing capacity procurement, exchange and cross-border capacity allocation. This principle could be used in the case of Kosovo and Albania reserve sharing project.

Finally, the following Table shows all types of agreements and contracts necessary to organize and implement the most efficient way of system balancing currently used in the most developed systems in Europe. There are four types of the contracts and it assumes that Kosovo and Albania create one common LFC block.

Table 17. Types of contracts needed for reserve sharing

Type of contract	Party	Description
Ancillary service contract in Kosovo and Albania (I)	BSPs with KOSTT BSPs with OST	Reserve provision inside control block KS-AL
Ancillary services contract in the neighboring systems (II)	BSPs from the neighboring system with KOSTT and OST	Reserve provision outside control block KS-AL
Balancing Energy contract	Traders, Producers with KOSTT and OST	No power reservation
Reserve sharing/exchange agreement	KOSTT, OST	Mutual sharing of reserves. Depends on available ATC
Emergency delivery contracts	KOSTT and OST with EMS, CGES, MEPSO	Activation through TRM
IGCC cooperation	ALL TSOs	Imbalance netting contract

Formal procedures for implementation of reserve dimensioning/sharing is given as follows:

Option 1. KOSTT and OST are independent LFC Blocks (individual reserve dimensioning)

1. KOSTT performs individual dimensioning process→ Outcome (aFRR, mFRR (MW))
2. OST performs individual dimensioning process → Outcome (aFRR, mFRR (MW))
3. KOSTT and OST share part of reserve mutually and with other LFC blocks (max 30 %)
4. KOSTT procures reserve power inside control block → Outcome (MW, €/MW)
5. KOSTT procures reserve outside control block → Outcome (MW, €/MW)
6. OST procures reserve power inside control block → Outcome (MW, €/MW)
7. OST procures reserve outside control block → Outcome (MW, €/MW)
8. KOSTT/OST share revenue from KS-ALB NTC allocation → Outcome (€/MW)

In this scenario separate LFC Blocks exist. In both LFC blocks individual reserve dimensioning and procurement process should be established. Whole value of cross-border transmission capacity is on a free market for cross-border trade.

Option 2. KOSTT and OST are within common LFC Block (common reserve dimensioning + reserve sharing with other LFC blocks)

1. KOSTT and OST perform common dimensioning for LFC Block → Outcome (aFRR, mFRR (MW))
2. KOSTT and OST share part of reserve with other LFC blocks (max 30 %)
3. KOSTT and OST agree on reserve capacity shares to be procured by each TSO
4. KOSTT procures reserve power inside control block→ Outcome (aFRR, mFRR (MW))
5. KOSTT procures reserve outside control block→ Outcome (aFRR, mFRR (MW))
6. OST Procures reserve power inside control block→ Outcome (aFRR, mFRR (MW))
7. OST Procures reserve outside control block→ Outcome (aFRR, mFRR (MW))
8. KOSTT and OST share revenue from KS-ALB NTC allocation

In this scenario common LFC Block exists. In common LFC block common reserve dimensioning and procurement process should be established. TSOs and NRAs should decide on the most appropriate option for cross-border transmission capacity allocation in between:

a) Cross-border capacity is not ensured in advance assuming it is usually not congested,
b) Cross-border capacity is ensured by balancing service provider (BSP),
c) Cross-border capacity is allocated by the TSO for system balancing needs.

Option 3. KOSTT and OST operate in the single market and common LFC Block

1. KOSTT and OST performs dimensioning process for LFC Block
2. KOSTT and OST share part of reserve with other control blocks (max 30 %)
3. KOST and OST agrees which part of power reserve should procure each TSO or it could be commonly procured
4. KOSTT procures reserve power inside and outside control block
5. OST Procures reserve power inside and outside control block
6. No KOSTT/OST revenue from KOSTT/OST NTC

As in most of the regional countries, the legislative set-up regarding the ancillary services and balancing mechanism is in place with some potential improvements needed. However, the main issue is when the market-based balancing and ancillary service mechanism will start with its full implementation on the market basis. In most cases, including Albania and Kosovo, there is only one ancillary service provider (and one service user on the national level). As suggested by the Energy Community Regulatory Board [10], the focus of balancing related activities for the majority of Energy Community Contracting Parties seems to be on implementing a market-based mechanism and subsequently cross-border exchange of balancing reserves and balancing energy, for which standardization of rules and procedures is needed. Optimization of resources on regional basis is only possible under a competitive regional market. An incentive mechanism for TSOs, together with the monitoring regime for NRAs, is needed to ensure that TSOs have the right incentives to operate the balancing mechanism as efficiently as possible.

Energy Community is also encouraging TSOs to work on regional level on the technical prerequisites necessary for balancing reserves and balancing energy exchange. TSOs should continue to cooperate and develop the framework for regional balancing mechanism. Voluntary work by EU TSOs on different regional balancing projects is a good example of cooperation that could be applied by the Energy Community Contracting Parties. This is exactly what KOSTT and OST have been preparing for the last couple of years.

7. CONCLUSIONS

With new set of European network codes and guidelines there is a large area for improvement of balancing mechanism around Europe. New legal framework is introducing new solutions aiming to integrate and optimize pan-European balancing mechanism and reduce system operation costs. Having that in mind the cooperation between the TSOs is possible and highly recommended through **common usage of reserve capacity** related to aFRR, mFRR and RR. Besides existing principle of individual reserve capacity dimensioning new network codes and guidelines introduce:

- **Common dimensioning:** Opportunity for TSOs within common LFC block to decrease the volume of total reserve capacity to the largest dimensioning incident in the common LFC block.
- **Exchange of reserve:** Opportunity for LFC block to procure part of its reserve (up to 50%) in another LFC block, changing geographical distribution of balancing reserves.
- **Reserve sharing:** Opportunity for LFC block to further decrease volume of reserve with common usage of one agreed part of the reserves with another LFC block. Implementation requirements are: 1) allowed if: 99% of LFC block imbalances in one year (probabilistic) - are lower than the dimensioning incident in MW (deterministic), 2) sharing volume is limited to 30% of the size of dimensioning incident.

Based on that, Kosovo and Albania now have 5 options for reserve capacity assessment, depending on their status in LFC block, as given in the following table.

Reserve capacity options depending on Kosovo and Albania status in LFC blocks	
Individual LFC blocks of Kosovo and Albania	**Common Kosovo-Albania LFC block**
Option 1. **Individual dimensioning**	Option 3. **Common dimensioning**
Option 2. **Individual dimensioning with reserve sharing**	Option 4. **Common dimensioning with reserve sharing**
	Option 5. **Common dimensioning with reserve exchange**

This study is dealing with power system reserve capacity, not balancing energy. Taking into account Kosovo and Albania power system specifics there are two reasons for their reserve capacity sharing/common dimensioning:

- **technical -** in the cases when TSO cannot provide needed reserve due to technical limitations
- **economic -** in the cases when balancing reserves located in another area are cheaper than domestic ones.

For Albania-Kosovo reserve capacity sharing/common dimensioning there are four main questions analyzed in this study:

1. What is the size of needed reserve capacity (products)?
2. What are the benefits of reserve capacity sharing/common dimensioning?

3. What is the level of cross-border transmission capacity needed for reserve reserve exchange/sharing/common dimensioning?
4. What is the method for cross-border transmission capacity allocation for this purpose?

The answers are recapped as follows:

1. What is the size of needed reserve capacity (products)?

Before clear definition of reserve capacity needs in Kosovo and Albania, area control error (ACE) issues have to be discussed and resolved. Actually, power systems of Kosovo and Albania are currently characterized with high level of ACE. In Albania in 2018 ACE was in the range between –555 MW and +225 MW, while in Kosovo ACE was in the range between -345 MW and +356 MW. In both cases it is higher than dimensioning incidents. As some of the TSOs use probabilistic approach with 99% threshold, which is requirement from SOGL, this would imply that OST would have needed +133 MW of positive FRR and – 177 MW of negative FRR to cover area control error, while Kosovo would need -166 MW and – 260 MW of FRR. Since ACE values significantly fluctuate in the last few years, for this exercise needed reserve capacity is estimated based on dimensioning incidents in both systems. It could not be expected from aFRR and mFRR to solve such large scale (not enough capacity, enlarge grid tariff) and long term (limited BSP reservoirs, expensive energy) imbalances in power system operation.

The 1st study finding/recommendation: as the first step it is recommended to decrease ACE with the following actions:

1. to introduce intraday market and enable balancing responsible parties (BRPs) (and TSOs, if BRPs do not perform intraday portfolio balancing) to buy/sell electricity from/to traders on the market price, without capacity payments. It is usual that balancing energy from reserve capacity is more expensive than electricity market price. However, in the case TSO is participating, its costs must be included in the network tariff or be allocated through balancing mechanism on the BRPs

2. to introduce incentives/penalties to all BRPs in the system. It will certainly decrease BRPs planning error and reserve capacity and balancing energy needs.

3. to sign TSO-TSO emergency delivery contract through TRM. It is usual procedure in the case of lack of energy in the LFC block. These contracts are used as last resort measure and are usually characterised by high electricity prices.

The 2nd study finding/recommendation: ***it is recommended to form common Kosovo-Albania LFC block and implement common reserve capacity dimensioning principle along with reserve sharing with other LFC blocks.***

As given in details in Chapter 5, individual dimensioning would result with total FRR capacity in Kosovo and Albania of +425/-230 MW. If reserve sharing is applied to individual dimensioning, then total FRR capacity would be decreased to +322/-185 MW. Common dimensioning (assuming Kosovo and Albania are in the same LFC block) would decrease it to +275/-180 MW, decreasing it for 150 MW from the starting value which would be released for market activities. Reserve exchange of Kosovo-Albania LFC block with other LCF blocks would not result with any decrease in total FRR capacity need. It would just be re-allocated in the other LCF block. The largest decrease in FRR capacity is found with common dimensioning and reserve sharing with other LFC block where total FRR capacity is additionally decreased to +192.5/-150 MW, which is 232.5 MW less than with individual dimensioning. This option is recommended as the best reserve capacity option for Kosovo and Albania.

TSOs within common LFC block can freely agree on the geographical and financial sharing of the reserve capacity.

2. What are the benefits of reserve capacity sharing/common dimensioning?

Currently KOSTT is not having FRR capacity contracted, while in Albania there is FRR capacity contract. Accordingly, cost-benefit is calculated here under initial assumption that both KOSTT and OST contracted FRR capacity based on individual dimensioning. Cost-benefit calculation is done under several additional assumptions. It is assumed that sum aFRR+mFRR is equal to dimensioning incident in both countries. RR is not contracted separately, as in most of the regional countries. aFRR is calculated with the ENTSO-e formula resulting with aFRR(KS)=±35 MW and aFRR(AL)=±45 MW. mFRR is not symmetrical (upward and downward), as it is the case in most of European countries. Due to high ACE and lower aFRR capacity price than mFRR capacity price, aFRR capacity is kept the same in both systems, and it is not commonly dimensioned. Reserve capacity price is the same for upward and downward. Reserve sharing is applied with proportional 30% decrease of mFRR upward and downward. aFRR capacity price is taken from the existing OST contract (2.18 €/MW), while mFRR capacity price is taken from the regional average (4.25 €/MW). It is also assumed that there is enough available reserve capacity in the neighboring LFC blocks and that reserve capacity cost in the neighboring LFC blocks is the same as in LFC block Kosovo-Albania.

The 3rd study finding/recommendation: Under these assumptions total mFRR costs in both countries with individual dimensioning (no matter where reserve capacities are located) is 18.4 mil.€/year. If reserve sharing is applied to individual dimensioning then the total costs would be decreased for 5.5 mil.€/year, or 30%. In the case of LFC block Kosovo – Albania is formed, common dimensioning can be applied with the costs decreased for 7.4 mil.€/year or 40.5%. Reserve exchange with neighboring LCF block would also be possible, but without any direct financial savings (assuming the same mFRR capacity price in the other block). Eventual benefits of reserve exchange would be to release some of the local reserve capacity for market activities.

However, ***common dimensioning combined with reserve sharing would assume potential saving of 11.6 mil.€/year in both systems or 63% compared to individual dimensioning***.

Besides savings in annual FRR reserve capacity costs, there are large savings in total annual electricity costs. With common dimensioning and reserve sharing some generation capacity is released for the market. ***It impacts electricity prices in both countries resulting with total annual saving in electricity costs of about 14 mil.€.*** In addition to that, there is a saving in reserve shortage. It is represented here as missing reserve capacity multiplied by number of hours with reserve capacity shortage. It is around 50 GWh. As expected, number of hours with congestion on Kosovo-Albania border is slightly increased.

Besides common usage of reserve capacity, Kosovo and Albania can apply common usage of balancing energy (which is out of scope of this study). Namely, it is related to the exchange of aFRR, mFRR and RR energy through:

- Imbalance netting
- Exchange of balancing energy over the common merit order List

The 4th study finding/recommendation: It is recommended to KOSTT and OST to establish imbalance netting and exchange of balancing energy to reduce amount of balancing energy activations for aFRR and mFRR in their systems, which would certainly result with lower costs for the provision of balancing energy.

Imbalance netting and the exchange of balancing energy are going to be obligatory.

On the other hand, the exchange of reserve capacity and reserve sharing are voluntary initiatives between two or more TSOs (GLEB, Art. 33(1) and 38(1)). However, a balancing report is also obligatory, and it should be published at least every 2 years by each TSO. In this report the opportunities for the reserve capacity exchange and reserve capacity sharing should be analysed, as well as an explanation and a justification for the procurement of reserve capacity without reserve capacity exchange or reserve capacity sharing (GLEB, Art.60(2.e- f)).

3. What is the level of cross-border transmission capacity needed for reserve capacity sharing/common dimensioning?

The answer on this question depends on the status of Kosovo and Albania LFC block(s). If Kosovo and Albania are in the same common LFC block, the KOSTT and OST can agree on the geographical distribution of the reserve capacity location. In other words, if Kosovo and Albania are in the same LFC block, the whole commonly dimensioned reserve capacity could be located in Albania (or in Kosovo). Also, any other capacity location share can be agreed among the TSOs, depending on availability, capacity prices and overall financial effects. The range of cross-border transmission capacity needed for reserve sharing /common dimensioning is given in the following table.

However, in the last few years NTC values on Kosovo – Albania border was mainly in the range 210-250 MW. The difference between NTC values and scheduled cross-border flows in direction from Albania to Kosovo (remaining cross-border capacity) in the period 2016-2018 was 192 MW. In the opposite direction, from Kosovo to Albania remaining cross-border capacity in the period 2016-2018 was 126 MW.

The 5th study finding/recommendation: ***there is a large remaining cross—border transmission capacity in both directions on Kosovo-Albania border. It is available for reserve capacity common dimensioning/sharing.*** Level of utilization of Kosovo-Albania cross-border capacities in the period 2016-2018 was 57% in direction from Kosovo to Albania and 25 % in direction from Albania to Kosovo. Moreover, with introduction of D-2 and ID capacity calculations NTC value can be increased based on KOSTT-OST calculation. Part of this additional NTC capacity can be used for reserve sharing. In addition, with new 400 kV line in operation NTC value on Kosovo-Albania border is expected to be increased for additional 600 MW. Part of that could also be used for reserve capacity common dimensioning/sharing, without limiting any other market activities. The range of cross-border transmission capacity needed for reserve sharing /common dimensioning is given in the following table.

Table 18. Cross-border capacity needed for reserve sharing

Cross-border capacity needed for reserve sharing (MW)	Kosovo→ Albania	Albania→ Kosovo
Individual dimensioning		
(50% of reserve capacity can be imported. Eventual aFRR capacity import can also be added to these values)	75	137.5
Common dimensioning		
(TSOs can agree on any geographical distribution of reserve capacites within the LFC block)	0-150	0-275
Reserve exchange		
(TSOs can greely agree on geographical distribution of reserve capacites within the LFC block)	0-150	0-275
Reserve sharing		
(TSOs can greely agree on geographical distribution of reserve capacites within the LFC block. 50% of reserve cpacity has to be located within the LFC block)	0-100	0-192.5

4. What is the method for cross-border transmission capacity allocation for reserve capacity common dimensioning/sharing?

There are two time periods to be considered in this process:

- **Period 1:** current national legal framework of Kosovo and Albania is in place, but still with no adopted and implemented EU network codes and guidelines
- **Period 2:** EU network codes and guidelines are adopted and implemented in Kosovo and Albania

The 6th study finding/recommendation: ***Under the existing practice and legal framework (period 1) reserve procurement, its activation and cross-border transmission capacity calculation and allocation are under sole responsibility of the TSOs and it can be arranged bilaterally. If the TSO procures system reserve from abroad, there are 5 currently applicable options for cross-border capacity allocation in the short-term***:

1. Cross-border capacity is not ensured in advance. Free cross-border capacity is used after the allocation at commercial market,
2. Usage of cross-border capacity reserved earlier by BSP, for the reserve exchange/sharing
3. Usage of cross-border capacity reserved earlier by TSO, for the reserve exchange/sharing
4. Update of cross-border capacity calculation (intra-day or even close to real time).
5. KOSTT and OST operate as one single market without bilateral NTCs. In this case there are no restrictions on balancing energy exchange and geographical distribution of reserve capacities. However, in that case there will be no revenues from cross-border capacity allocation.

Analyses for Kosovo-Albania border, as well as for SEE region [11] show that at the intra-day time horizon, significant part of cross-border transmission capacity is free, due to netting of counter transactions at borders, after the nomination and scheduling process. Therefore, it is recommended to used options 1 (as it is the case in Slovenia-Croatia-BiH LFC block and Serbia-Macedonia-Montenegro LFC block) and/or 2 for the short-term.

The 7th study finding/recommendation: ***Under new EU network codes and guidelines (period 2) TSOs are not allowed to increase TRM for exchanging/sharing of balancing capacity for FRR or RR, while FCR can be exchanged using TRM, calculated as described by CACM. However, it is allowed to allocate available cross-border capacity for the exchange of balancing capacity or reserve sharing in the long-term. In that case there are 3 methods for cross-border transmission capacity allocation in the long-term, as described in Chapter 4:***

1. Allocation process based on Economic Efficiency Analysis,
2. Market-based allocation process and
3. Co-optimized allocation process.

In GLEB the preferred approach for cross-border transmission capacity allocation for balancing capacity of reserve sharing is the Co-optimized Allocation. However, for Kosovo and Albania case it is recommended to use Economic Efficiency Analysis for cross-border capacity for balancing integration, as the method feasible even in not developed balancing markets.

8. LITERATURE

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9. ANNEX 1 – ACE INPUT DATA SETS

9.1. Background

One of the most important indicators of system operation and balancing mechanism is area control error (ACE). ACE is defined as the sum of the power control error ('ΔP', that is the real-time difference between the measured actual real time power interchange value ('P') and the control program ('P0') of a specific LFC area or LFC block) and the frequency control error ('K*Δf', that is the product of the K-factor[15] and the frequency deviation of that specific LFC area or LFC block), where the area control error equals ΔP+K*Δf. In short, it is a measure of power system surplus or deficit with respect to planned cross-border exchanges.

During preparation of the Study three sets of input data on area control error (ACE) have been collected from the system operators KOSTT and OST as follows:

	OST	KOSTT
ACE 2017	10.12.2018 (1 h series)	01.11.2018 (1 h series)
ACE 2017	27.03.2019 (15 min series)	
ACE 2018	03.05.2019 (15 min series)	06.05.2019 (1 h series)

In the following figures these sets of data are labeled as:

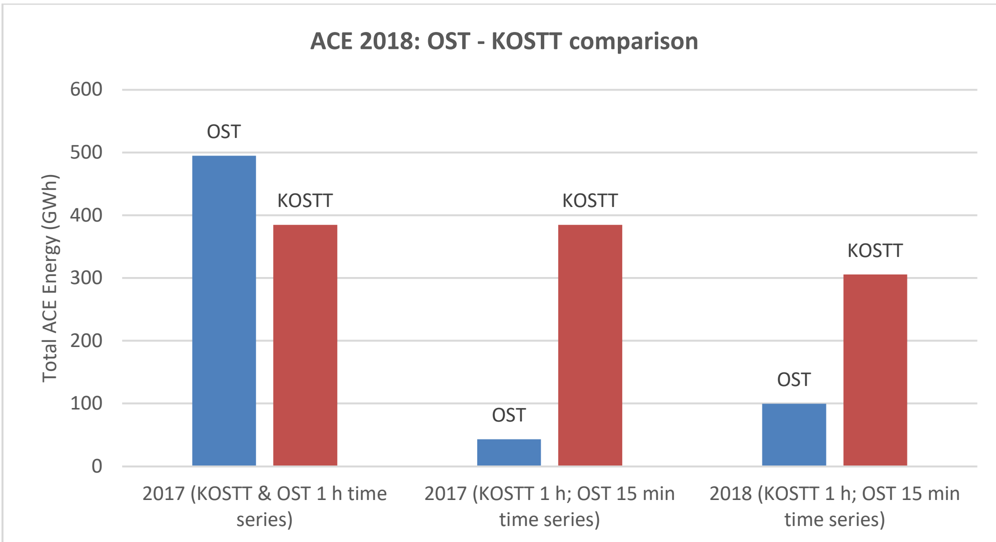
1) 2017 (KOSTT & OST 1 h time series)
2) 2018 (KOSTT 1 h; OST 15 min time series)
3) 2018 (KOSTT 1 h; OST 15 min time series)

Since these data can have significant impact on calculation of benefits for both countries with common approach instead of existing individual, it's been required to prepare this Annex with more details on input data sets. It is given in the following charts and tables without going into the reason for such a significant change.

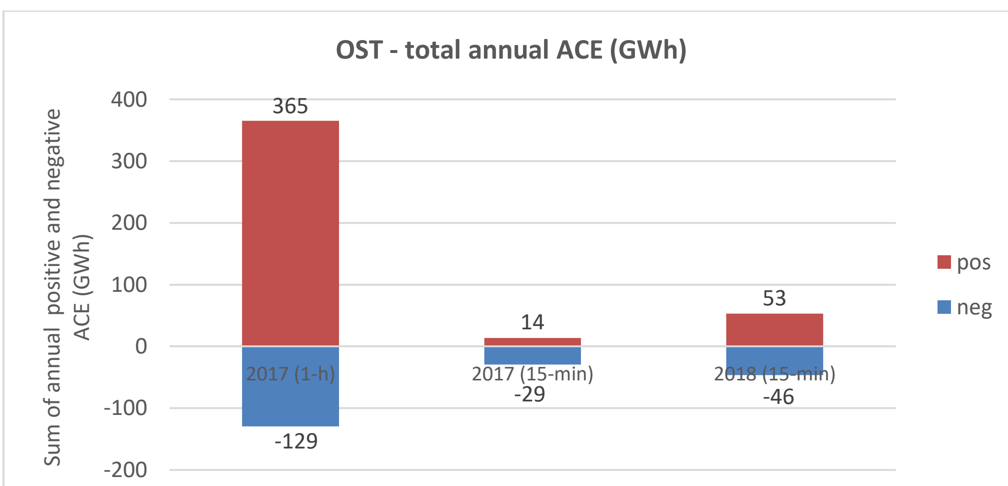
[15] K-factor is a value expressed in megawatts per hertz (MW/Hz), which is as close as practical to, or greater than the sum of the auto-control of generation, self-regulation of load and of the contribution of frequency containment reserve relative to the maximum steady-state frequency deviation.

9.2. Data comparison

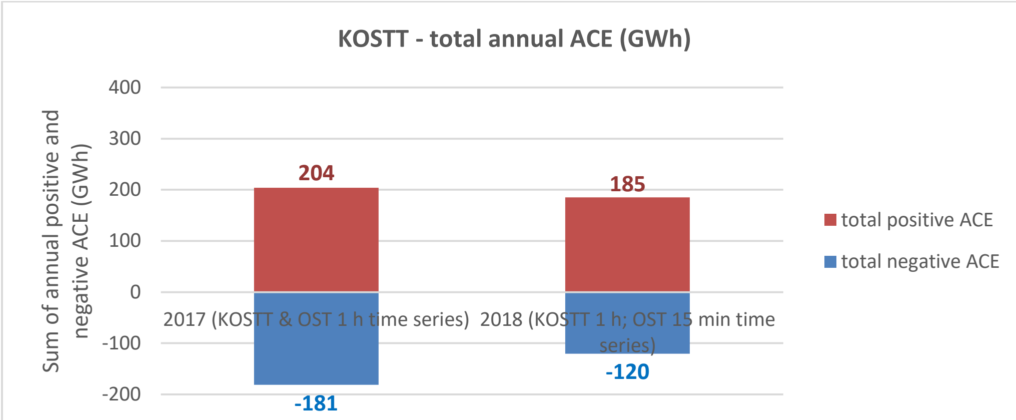
ACE values for Albania for 2017 significantly differ in 1-hour and 15-min time series, while the ACE values for Kosovo are quite consistent in all three data sets delivered, as shown on the following figure.



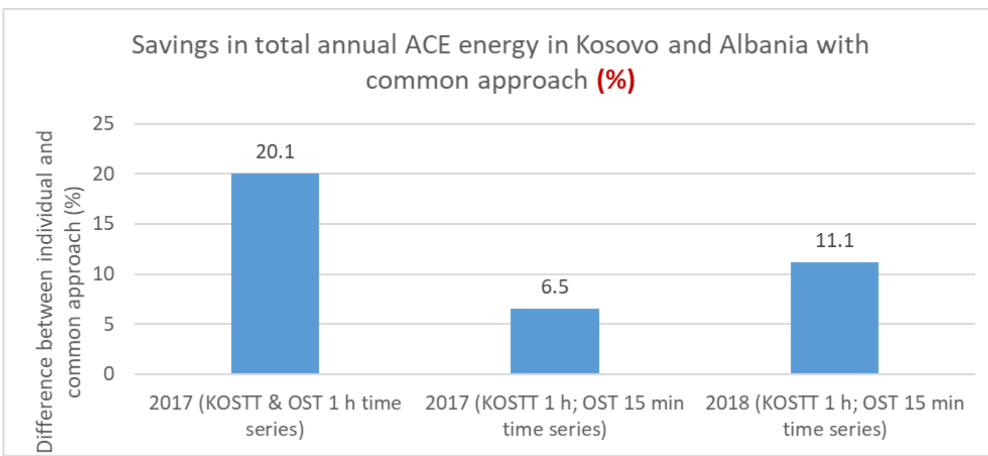
Two sets of ACE data for 2017 delivered by OST differ dramatically, in total sum of ACE energy for 2017 was 494 GWh, while the second set of data reduced it for more than 90% to just 43 GWh, as shown on the following figure. The data for 2018 shows more than twice higher total value of 99 GWh.



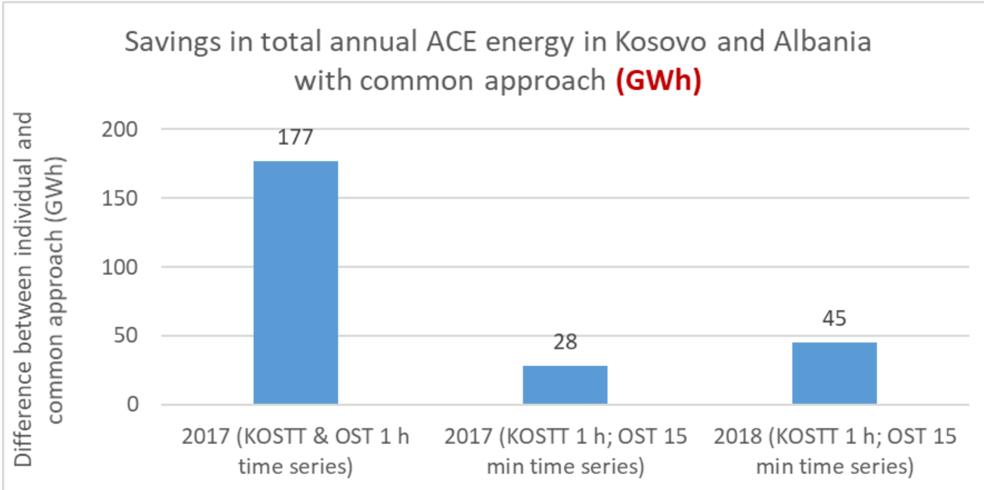
On the other side Kosovo inputs are delivered in two sets: one for 2017 and one for 2018, both in 1-hour time series. Total sum of ACE values are comparable: 385 GWh in 2017 and 305 GWh in 2018.



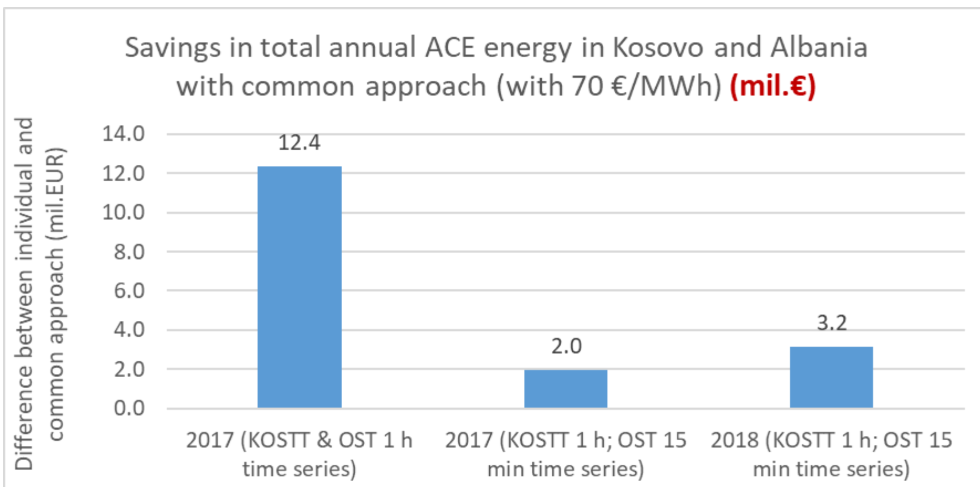
Input data variations have significant impact on the calculation of the benefits of common system operation of Kosovo and Albania system, as shown on the following figure. With the first set of data total savings with common approach would be 20.1% of the total ACE energy with individual approach. But, with the following two sets of data it drops to 6.5% and 11.1%.



Common approach to ACE would result with significant savings, both in energy and financial terms. Common approach with the first sets of input data (2017) would result with 177 GWh/year lower total ACE energy compared to existing individual approach. Common approach with the second sets of input data (2017) would result with 28 GWh/year lower total ACE energy compared to existing individual approach, while common approach with the third sets of input data (2018) would result with 45 GWh/year lower total ACE energy compared to existing individual approach.



If we assume that price of electricity used to cover ACE is 70 €/MWh, total financial effect would be 12.4 mil.€/year with the first set of data, while for new sets of data it drops to 2 – 3.2 mil.€/year, as shown on the following figure. Clearly, with lower electricity price these savings would additionally decrease.



9.3. Conclusion

During preparation of the Study three sets of same input data on area control error (ACE) have been collected from the system operators KOSTT and OST. Since these data can have significant impact on calculation of benefits for both countries with common approach instead of existing individual, it's been required to prepare this Annex with more details on input data sets differences.

With the first set of input data savings with common approach compared to existing individual approach would be 12,4 mil.€/year. With the second input data set it would be 2 mil.€/year, while with the third set of input data it would be 3,2 mil.€/year.

Since it is estimated hereby that these input data variations assume differences in potential financial savings with Kosovo-Albania power system integrations on the level of 10 mil.€/year just for energy part (reserve capacity sharing is additional issue), it would be helpful to clarify the reasons for Albanian ACE data variations and to finally evaluate potential system integration benefits on the larger time frame of several years.